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FINAL REPORT

RASPBERRY TRELLISING DEVELOPMENTS AND YIELD EXTENSION TRIALS

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Raspberry Trellising Developments and Yield Extension Trials

ADF Project # 97000282-84BV

Final Report

March 2001

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Raspberry Trellising Developments and Yield Extension Trials

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Executive Summary

This project was initiated by Dr. Ken Giles in 1997 and was subsequently taken over by Karen Tanino. Many students and research assistants contributed to the project over the past several years (see attached). Large scale production of raspberries on the prairies has the potential to yield profits for producers. This project is investigating a method of trellising raspberry canes to make harvesting the ripe fruit more efficient for both hand pickers and machines. The project is based on work that Herb Stiles of the Virginia Polytechnic Institute and State University originally completed at the Southern Piedmont Agricultural Research and Extension Center (SPAREC) near Blackstone, VA. The purpose of a shift trellising system is to train flowers onto one side of the cane. From dormancy until bloom, floricanes are trained horizontally on the arm. The phototropic tendency of the floricanes' fruiting shoots trains the shoots skyward, eliminating much of the undesirable growth patterns that occur on vertical trellises (Melnick, 1996). The shift trellis in pre-bloom position suspends fruiting wood (floricanes) horizontally; fruiting shoots grow upwards. New canes (primocanes) develop on the opposite side. After bloom, the floricane curtain is rotated to a vertical position creating a hanging wall of fruit. The system provides increased visibility and accessibility of crop, resulting in reduced harvest costs and more timely picking of fruit (Melnick, 1996).

We modified this trellis system for management purposes. However, it is concluded that no consistent advantage of trellising is evident. Moreover, trellising results in significant management effort and is unwarranted at this time.

Conversely, there are promising primocane selections (SX81-205-9 and SX81-205-15) which begin to bear fruit in early to mid August with relatively good fruit quality and yield. These selections have comparable berry size to Double Delight. Furthermore, they have higher Brix levels and are less acidic than Double Delight. SX81-205-9 had 60% greater yield on a per m2 basis compared with Double Delight. These responses should continue to be measured at differing cane densities and time to determine optimum cultural practise and determine yields over years with varying environmental conditions.

The following final report summarizes 3 years of work.

Raspberry Trellising Developments and Yield Extension Trials

Project Synopsis

Large scale production of raspberries on the prairies has the potential to yield profits for producers. This project is investigating a method of trellising raspberry canes to make harvesting the ripe fruit more efficient for both hand pickers and machines. The project is based on work that Herb Stiles of the Virginia Polytechnic Institute and State University originally completed at the Southern Piedmont Agricultural Research and Extension Center (SPAREC) near Blackstone, VA.

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Project History

The Raspberry Trellising Development Project was initiated in May, 1998 under the supervision of Ken Giles. From July 1, 1998, Karen Tanino took over the project after Ken Giles retired.

Project Objective

The management and controlled growth of raspberries on a field scale requires their careful and controlled trellising. This is particularly true of varieties that are floricanes which fruit only in the second year of cane growth. Techniques have been developed within the program already wherein one side of a raspberry row is cut back in each alternate year so that only half of the row is fruiting at any one time. This has been done to date using removable wire trellising on either side of the row to hold the canes upright during growth and make fruit picking simpler, thus bringing in more revenue from pick-your-own customers. Obtaining high yields with raspberries focuses on four key points. 1) Pre-planting preparation, 2) Fertility management, 3) Pest and disease controls and 4) Cane management. This project involves the fourth of these requirements and relates to altering the fruiting structure of the cane, making picking simpler. It requires that canes be trellised by outlying wires from the mainframe and grown at a pronounced angle to

induce lateral flowering buds to develop on the one side of the cane. Once the fruit is produced, it exposes the fruit to pickers either hand or mechanical on the side of the row. This means that picking fruits within the stand of canes is simplified and maximum fruit potential is obtained. In addition, this project will monitor primocane types which yield later in the season than floricane types.

Reason

Cane management in raspberry cropping is of key importance because of the structure of the fruiting cane itself. Floricane raspberry plants are biennials in that the cane grows up in the first year to produce lateral fruiting shoots only in the second year. The first year, cane grows slowly at first, rapidly during the summer and slowing down during the fall. The internode arrangement along the cane is very precisely governed and in the fruiting year, the laterals develop from the tip of the cane downwards and some of the basal nodes on the cane may not develop fruiting laterals. The structure of the laterals is dependent upon their position on the cane. The fruiting structure of the plant is critical because of cane number and the competition between first and second year canes. Experimental work has shown that the number of canes per yard of row is optimally between 9 – 14 fruiting canes. Below that figure the yields are low and above that figure the yields begin to tail off slowly as does berry size. In order to maximize the quality and quantity of berry fruit, control of the first year canes is important as is the orientation and length of the fruiting cane (Dale, 1995). A swing trellis developed by Dr. Stiles offers some potential for training the second year canes to provide an opportunity for lateral branch formation towards the light on one side of the cane. At flowering, when lateral position has been set, the trellis is moved so the fruiting cane becomes upright and in this system the young canes will grow away from the fruiting canes towards the light. The system has many advantages that need to be vindicated and proven under Saskatchewan conditions.

Materials and Methods

a) Trellised Floricanes

An existing stand of trellised raspberries at the University of Saskatchewan, Horticulture research plots in Saskatoon was chosen for the project site (Table 1). Some of the cultivars represent the new releases from the department: SK-Red Mammoth (SX84-34, Fig. B) and SK-Red Bounty (SX84-35, Fig. C). In addition, Boyne and Min 657 were used. Over the 3 years (1998, 1999, 2000), three different methods were used to achieve the same end result of cane bending. An easier system and more effective method was sought for growers. However, this is a high management practice. The existing trellis was initially modified to accommodate a new moving trellis. The existing trellises had a drip line irrigation system in place that was set two feet above ground level. The new shift trellis was installed above the dripline so that it would not interfere with the existing irrigation system. In May 1998, 1999, 2000, the raspberry patch was thinned of dead wood, weeded and roto-tilled, and irrigated as needed.

Table 1. Raspberry Plots at the University of Saskatchewan N →

Row	+/- Trellis	← Cultivars/Selections →					
16		M8114	M8114	M8008	M8114	SX81-205-1	SX81-205-9
15		M8008	M8008	M8114	M8008	M8112	SX81-205-15
14		1 x 8	1 x 8	1 x 8	1 x 8	M8006	Min659
13		1 x 8	1 x 8	1 x 8	1 x 8	Min659	Min629
12	Guard	SX84-35	SX84-35	SX84-35	SX84-35	SX81-205-15	M8114
11	+	SX84-34	SX84-35	Min657	SX84-34	SX81-205-9	SX81-205-9
10	-	SX84-34	SX84-35	Min657	SX84-34	Min629	M8112
9	+	Min656	Min657	Min 656	Min 657	M8114	M8006
8	+	Min656	Min657	Min656	Min 657	Min659	M8114
7	-	SX84-35	Boyne	Boyne	SX84-35	Min629	SX81-205-9
6	+	SX84-35	Boyne	Boyne	SX84-35	M8114	SX81-205-15
5	+	Min657	SX84-34	SX84-35	Boyne	M8112	M8112
4	+	Min657	SX84-34	SX84-35	Boyne	SX81-205-9	M8006
3	+	Boyne	Min656	SX84-34	Min656	M8006	Min659
2	+	Boyne	Min656	SX84-34	Min656	SX81-205-15	Min629
1	Guard	SX84-35	SX84-35	SX84-35	SX84-35	Festival	K81-6

Floricane trellising trials ← → Primocanes

← 30 m →

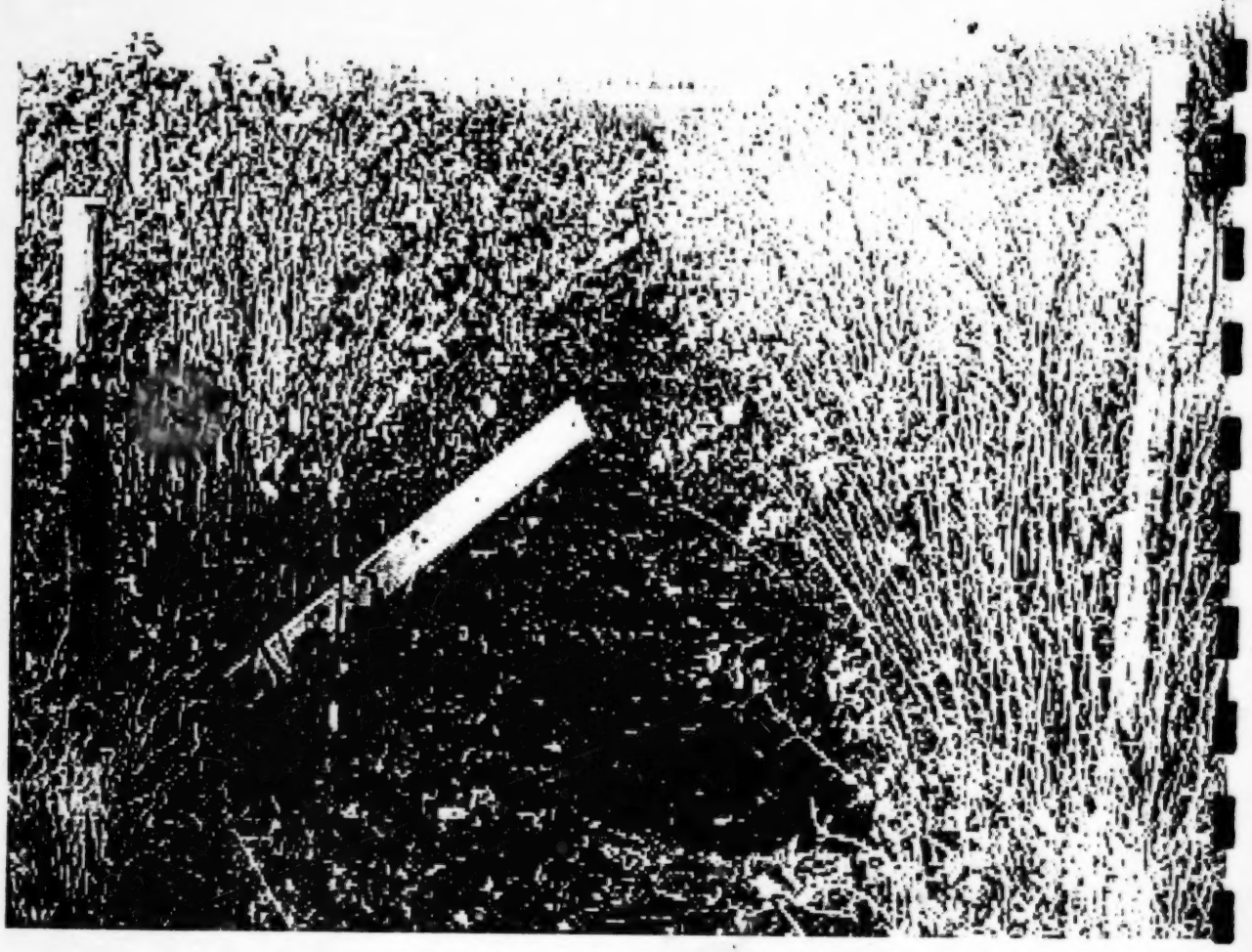


Figure A. Trellised (left) and non-trellised (right) raspberry canes in October, 1999.

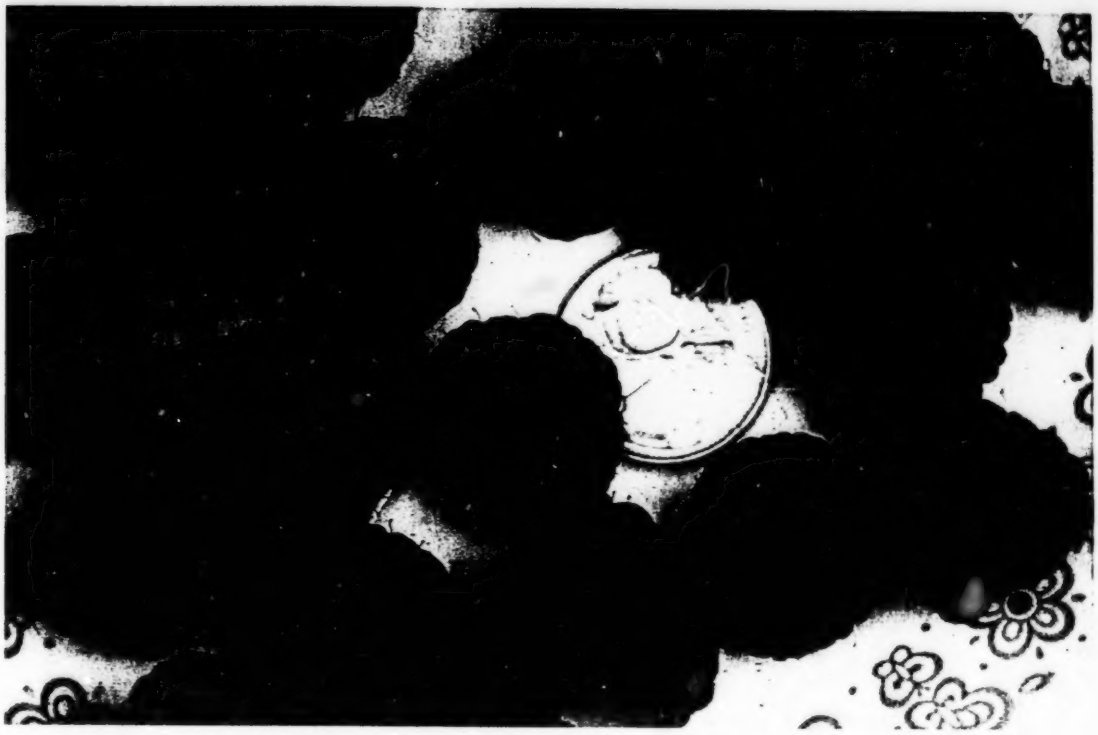


Figure B. "SK-Red Mammoth", a University of Saskatchewan floricane cultivar release.

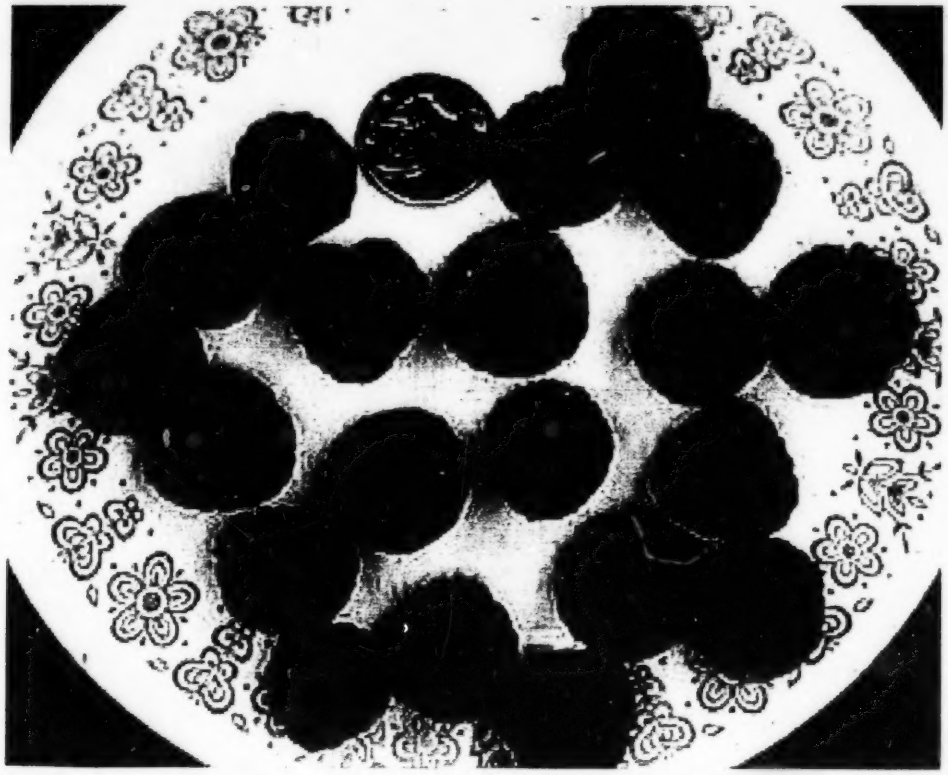


Figure C. "SK-Red Bounty", a University of Saskatchewan floricane cultivar release.

Each year at floral initiation, the canes were bent over the trellis to face east. In 1998, the trellis was composed of wire supplemented with nylon rope tied to a wood pivot. The canes remained in this position until fruit set. The canes were then swung back up into their upright position. In 1999, a wooden pivot was constructed and canes were again bent with nylon rope (Fig. A) and canes were left in this position throughout the growing season. In 2000, trellising was applied before flowering to a short width of 5 – 6 canes with 2 samplings per rep and 4 reps per floricane selection. The short width permitted bending of canes to near 90° angles to exaggerate the trellising effect. Canes were bent over toward the east (rows ran north/south) with 2 flat wooden slats tied together with twine and nailed into the ground with 8" spikes. As in 1999, canes were held in this position throughout the growing season. Treatments were sampled in 2000 over time for: a) Fresh weight, dry weight, % water content, % dry weight; b) pH, Brix, Colour (L, A, and B values); c) Total yield per cane; d) Picking time per cane; and e) yield per 20 fruit weight (berry size). Samplings began July 20/22, 2000 and ended August 19 of that year.

In June 1998, 1999, 2000, the raspberries were fertilized with 17-20-0 Ammonium Phosphate/Ammonium Sulfate at a rate of 100 lb of nitrogen per acre (2.34 kg fertilizer per row, side-banded into the soil on each side of raspberries).

Data on budding was taken in late June, 1998. The number of buds on the east side (full exposure to the sun) were counted compared to the west side (shaded side). The ratio of number of buds on the east:west was 3:1. Raspberries were harvested from the rows in two randomly selected 1 meter lengths in each trial. Data was taken from both trellised and untrellised rows with 4 reps per cultivar per treatment.

The taller varieties of Boyne and SX84-34 adapted well to the trellising system while the shorter growing varieties, Min 656 are not suited to trellising. The trellised raspberries were found to be easier to pick since the ripe raspberries are easier to find. Trellising helps to support the canes which normally bend over in the untrellised sections.

b) Primocane Raspberries

Primocane raspberries have a very significant advantage of cane management over floricane types (Fig. D). Canes are mowed down on an annual basis without having to selectively remove old fruiting floricanes.

Primocane yields were taken on 9 types (M8114, M8112, M8008, M8006, SX81-205-1, SX81-205-9, SX81-205-15, Min 659 and Min 629). Two-1 meter samples were collected for each rep with 4 reps per primocane type. Harvest date varied between years but was consistently earliest for SX81-205-9 and SX81-205-15. These selections began fruiting in mid August on average. Primocanes were also sampled in 2000 over the growing season from August 7, 2000 through to September 9 for: yield, pH, brix, colour as well as fresh weight, dry weight, % water content per berry.

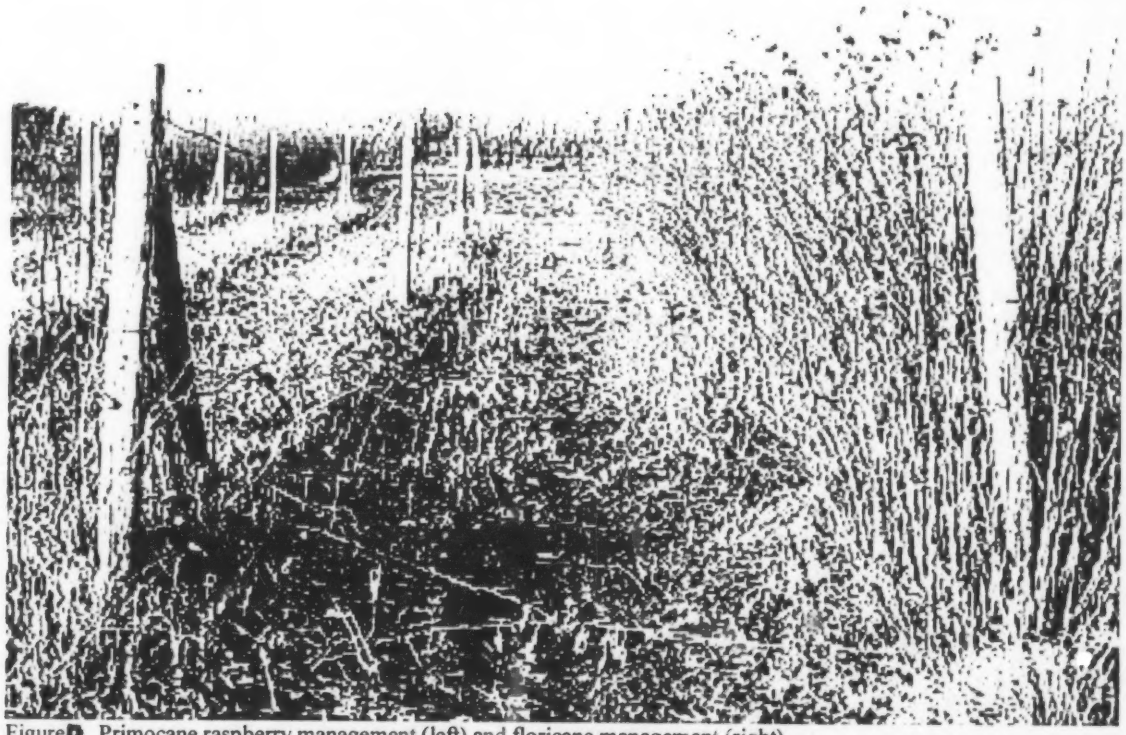


Figure D. Primocane raspberry management (left) and floricane management (right).

Section A: Floricane Selections

Results and Discussion

Section A: Floricane Cultivars

In all 3 years, trellising did not have a significant effect on yield. In 1998, while trellising effectively altered fruiting ratio on one side of the trellis 3:1, trellising itself did not influence total yield. In 1999, early season yields of trellised floricanes were higher than non-trellised treatments (Figure D). However, yields were not significantly different by mid-season. Total shoot biomass of new primocanes was not significantly different between trellised and non-trellised treatments except Boyne which expressed higher biomass under trellising (Fig. E). While mean fruit size decreased under trellising, the response was not significant (Fig. F). Two yielding types were apparent in floricane profiles: early and late maturing. The early maturing types completed maturity earlier than late maturing (Fig. G). In all selections except Min 657 (early maturing type), trellising increased yield at the beginning of the harvest. Yield was not significantly different from mid season onward. This is likely due to the increasing competition from the new cane growth in the trellised trials (Fig. A). By the end of the season, both trellised and non-trellised trials were similar in appearance. Fruit size as indicated by fruit weight (taken on 20 fruit, 4 replications) was not significantly different between trellised and non-trellised treatments for all selections (Fig. H).

In 2000, the following was determined:

- Fresh weight
    - No difference detected between trellised and non-trellised treatments for SX84-34, SX84-35 and 'Boyne' (Figs. 1 – 3). Min 656 and Min 657 (Figs. 4 and 5) had higher fresh weights under non-trellising on the July 29 and August 19 sampling dates.
    - Mean fresh weight of SX84-34 was highest at 57.2g (2.86 g/fruit) followed by SX84-35 (50.6 g), Min 657 (45.6 g), Min 656 (45.3 g), and Boyne (34.4 g) on a 20 berry sample (Figs. 1 – 5). The newly released cultivar, Souris, had a mean fruit weight of 2.52 g. (Davidson, 1994b) which is lower than SX84-34 with a mean fruit weight of 2.86 g/fruit.

- Dry Weight
    - Dry weight varied between samples from 7.5 g (SX84-34) to 5.2 g (Min 657).
    - Dry weight was similar throughout the season.
    - There was no consistent difference between trellised and non-trellised treatments, however, in Min 656 and Min 657, on average, trellising decreased dry weight.

- Percent Water Content
    - There was no consistent difference in water content between floricane selections and between trellising and non-trellising treatments. Mean water content was 86.8%.

Note: no data was available in some cases and these results do not reflect "0" % water content.

In spite of the lack of yield effect, trellising appeared to enhance picking efficiency but this result varied between years. In 1998, picking rate increased by as much as 50% on trellised compared with untrellised canes (Table 2). In 2000, however, no significant difference in picking efficiency was detected but mean picking time was lower for Min 657 (Figs. 41-45). Different personnel between 1998 and 2000 may have contributed to this difference.

In addition, in the year 2000 trials, the following was found:

- PH (Figs. 16 – 20)
  - No differences were detected between floricane selections or trellising over the season.
  - PH remained the same throughout the season.
  - Mean pH = 3.2

- Brix (Figs. 21 – 25)
  - Brix levels were similar throughout the sampling period over the season.
  - There was no difference between floricane selections in Brix levels.
  - Trellising did not change levels of Brix.
  - Mean Brix content = 11.3

- Colour (Figs. 26 – 40)

L-Values represent the degree of lightness of colour and the chroma values are a measure of the intensity or brightness of the hue (visible colour) (Perkins-Veazie and Nonnecke, 1992).

- As per Brix response, levels were similar over the season. However, the "A" colour component dropped off at the end of the season for 'Boyne' and thus the chroma for Boyne was lower than the other selections. Since samples were tested after freezing, this may be due to relative poorer storability (frozen) compared to the other selections.
- No differences between trellising and non-trellising treatments.
- Large standard deviations evident.

Chroma: calculated as the square root of $a^2 + b^2$ (Singha and Townsend, 1989).

	a value		b value		Chroma	
Cultivar	**Trellised**	**Untrellised**	**Trellised**	**Untrellised**	**Trellised**	**Untrellised**
SX 84-34	34.2	34.3	10.8	11.0	35.8	36
SX 84-35	30.1	32	10.1	10.9	31.7	33.8
Boyne	27.9	26.8	7.5	7.1	28.8	27.7
Min 656	28.7	31.2	8.75	9.8	30	32.7
Min 657	32.6	33.8	10.3	11.4	34.2	35.6

Table 2

1998 Raspberry Trellising ---- picking trials

Date	Cultivar	Trellised/Untrellised	Avg. Fruit (g)/min
July 20	Min 657	T	34.6
		UT	35.7
July 21	SX 84-34	T	28.8
		UT	18.5
	SX 84-35	T	40.0
		UT	37.8
July 28	Boyne	T	37.3
		UT	25.5
	Min 657	T	42.2
		UT	46.9
	SX 84-35	T	30.3
		UT	48.4
	SX 84-34	T	16.5
		UT	9.6
August 4	Min 657	T	46.5
		UT	36.5
	Boyne	T	34.3
		UT	27.5
	SX 84-35	T	49.1
		UT	32.2
	SX 84-34	T	54.3
		UT	40.0
August 10	Min 657	T	44.5
		UT	32.3
	Boyne	T	28.3
		UT	31.5
	SX 84-35	T	53.9
		UT	41.5
	SX 84-34	T	42.9
		UT	52.1
August 17	Min 657	T	23.9
		UT	28.9
	Boyne	T	25
		UT	26.5
August 19	SX 84-34	T	34.9
		UT	37.9
	SX 84-35	T	42.5
		UT	35.7
	Min 657	T	24.6
		UT	27.8
	Boyne	T	33.75
		UT	33.3

Total Yield per Cane (Figs. 46 – 50)

- SX84-34
  - Sampled July 20 – August 17
  - Non-trellised (62 g) significantly different than trellised (48 g).
  - Peak yield on August 3rd.
  - By August 10, yield had decreased to 52 g (Non-trellised) and 32 g (trellised).

- SX84-35
  - Peak yield occurred on August 3rd
  - Trellising increased yield: on July 20: 21 g (trellised), 10 g (non-trellised); July 27: 35 g (trellised) and 22 g non-trellised.
  - Thereafter, no difference between treatments.

- Boyne
  - No difference between trellising treatments
  - Peak: 43 g per cane (non trellised) and 35 g/cane (trellised) on Aug. 3rd.

- Min 657
  - No difference between trellising treatments
  - Peak: 36 g per cane (non trellised) and 31 g/cane (trellised) on Aug. 3rd.
  - By August 17, declined slightly to: 28 g/cane (trellised) and 24 g/cane (non-trellised).

  - Min 657
    - Peak yield occurred earliest on July 27th
    - Non-trellised significantly increased yield over trellised:
      - July 27th: 24 g/cane = trellised; 38 g/cane for non-trellised
      - August 10th: 10 g/cane = trellised; 24 g/cane = non-trellised.

The reduction of total yield per cane due to our trellising techniques may be a result of shading by adjacent rows. A recent publication by Vanden Heuvel et al. (2000) indicates that staking raspberry canes produced superior yields in the cultivar Boyne by 68% over non-staked canes. This increase was related to greater leaf area but not a change in floricane structure. Furthermore, Dale (1989) reports that between row spacings had a greater effect on yield than the distance within row. This again may be due to shading effects. While trellising is supposed to improve light capture, this trellising system may have induced more shading of the plants since a near 90° angle bend of the canes produced shading on one half of the cane. Surprisingly, certain cultivars such as Boyne, Min 657 showed no difference between trellised and non-trellised treatments while SX85-35 actually increased yields due to trellising.

Fig. D **Raspberry Production of Trellised and Non-Trellised Trt. in 1999**

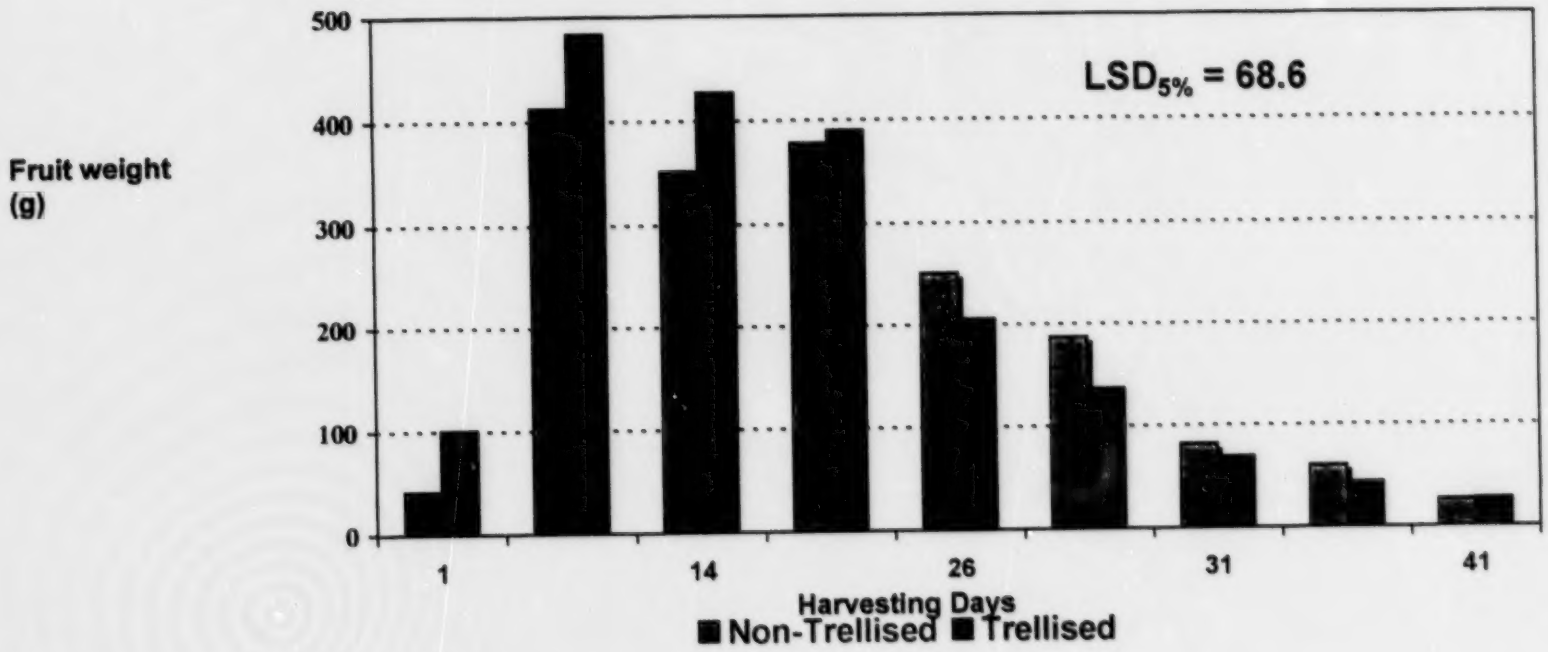


Fig. E Raspberry Shoot Dry Weight (g) of Trellised and Non-Trellised in 1999

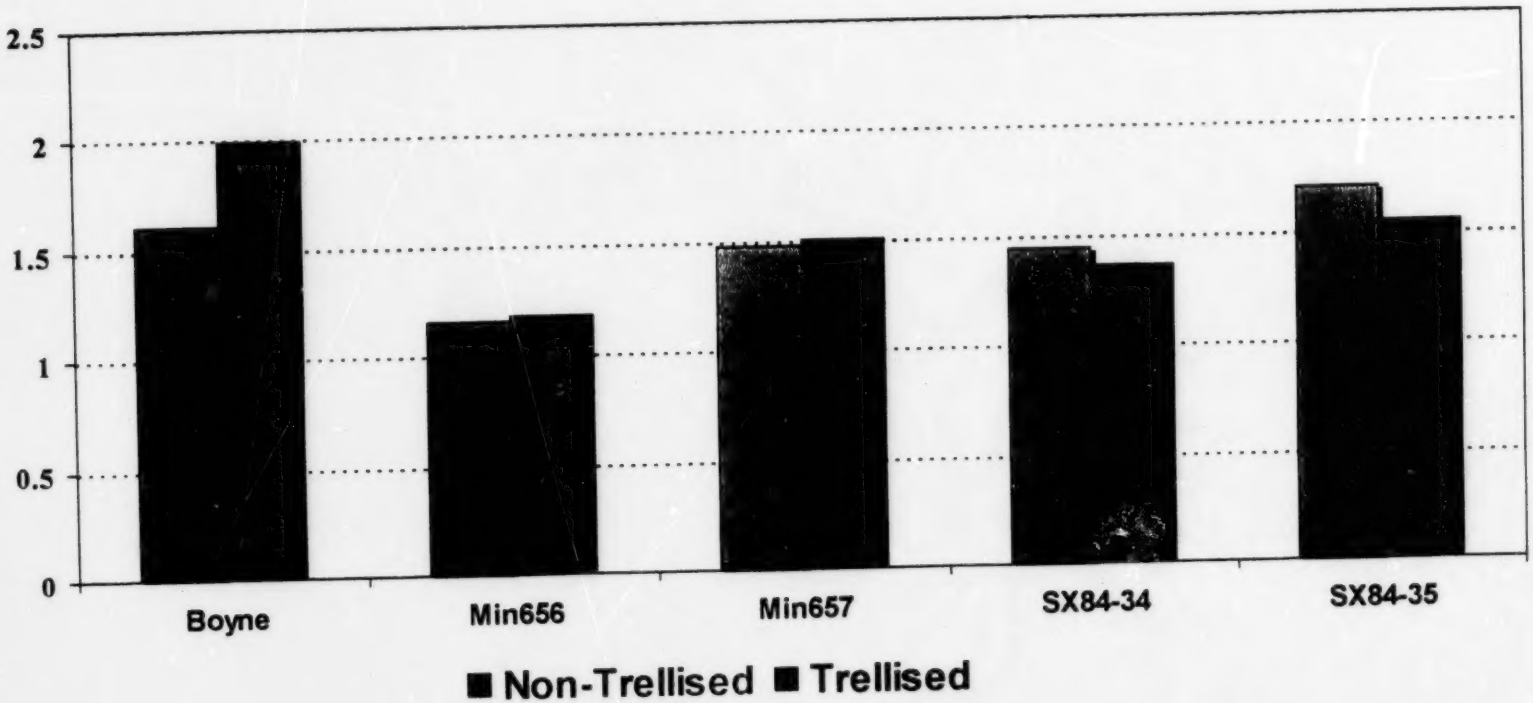


Fig. F Single Fruit Weight (g) of Raspberry from Trellised and Non-Trellised in 1999

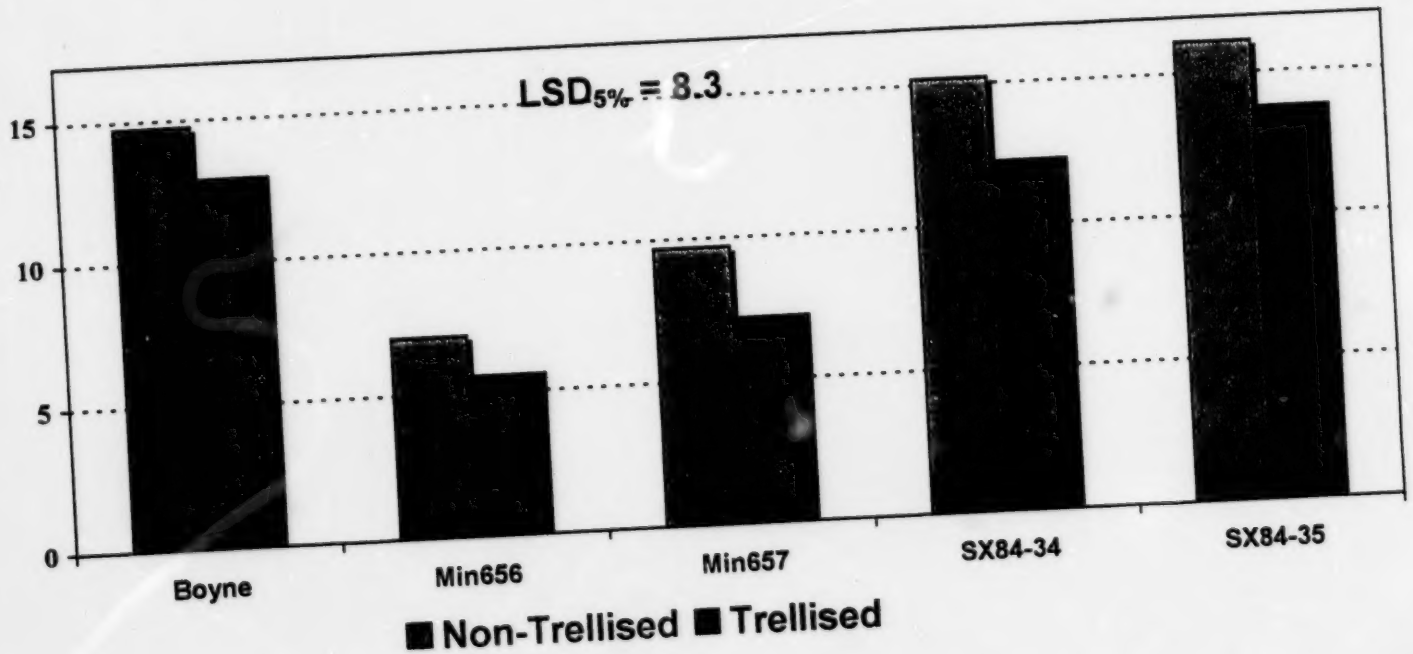


Fig. G **Raspberry Production (Fruit weight, g) of Trellised and Non-Trellised Trt. in 1999**

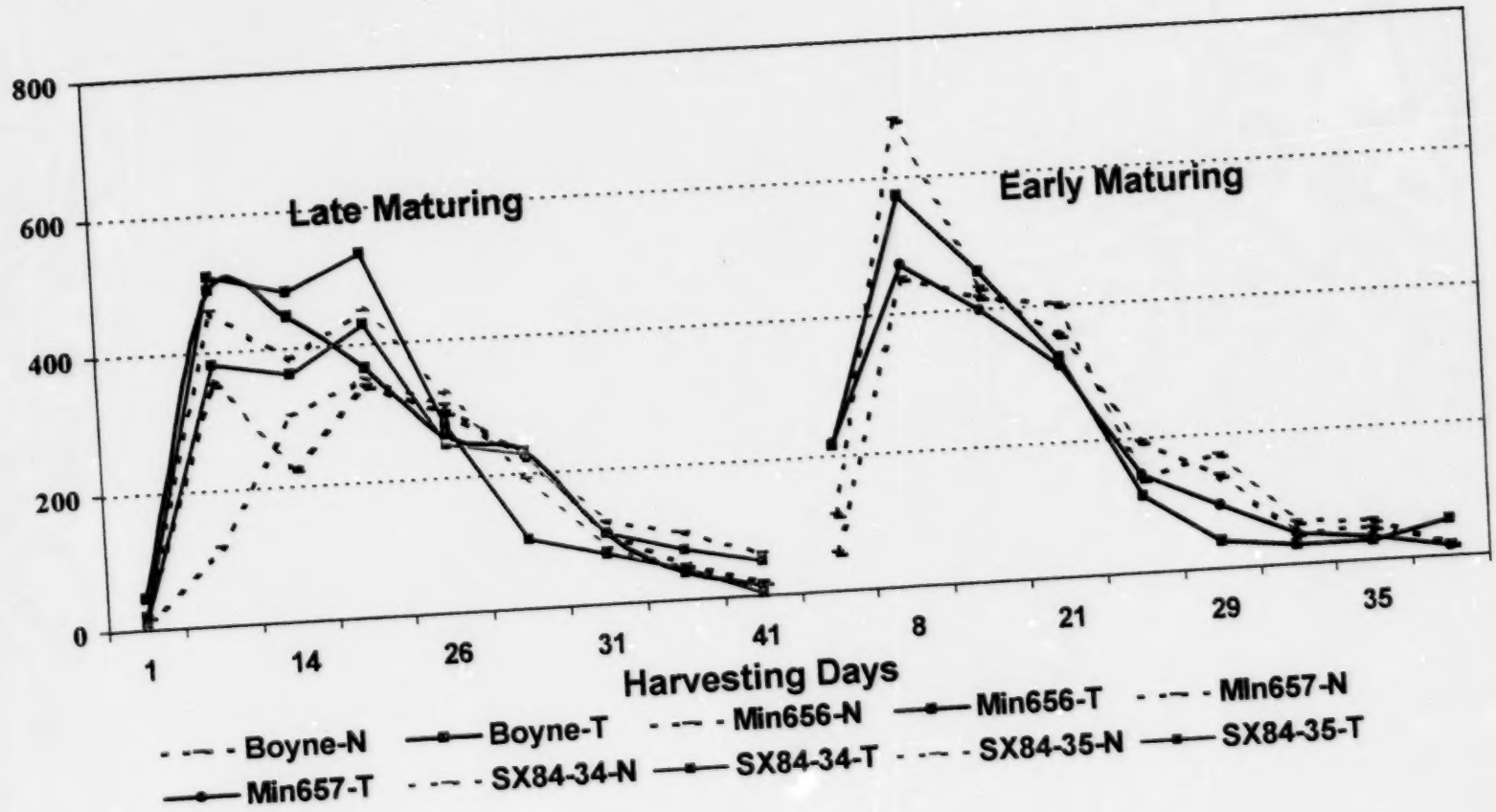
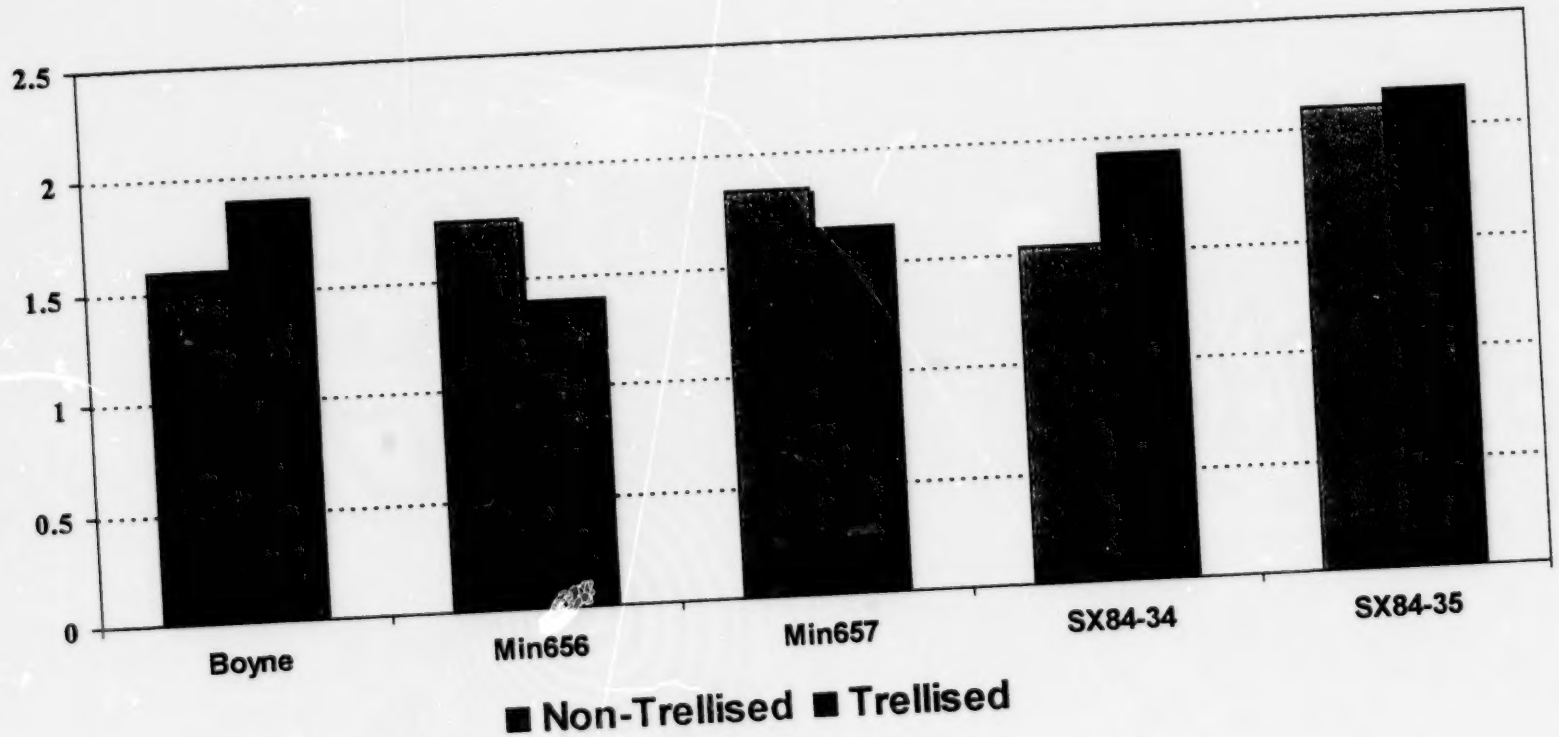


Fig. H **Raspberry Production (Fruit weight, g) of Trellised and Non-Trellised Trt. in 1999**



MEAN FRESH WEIGHT (g) OF 20 BERRIES, July22-August19, 2000

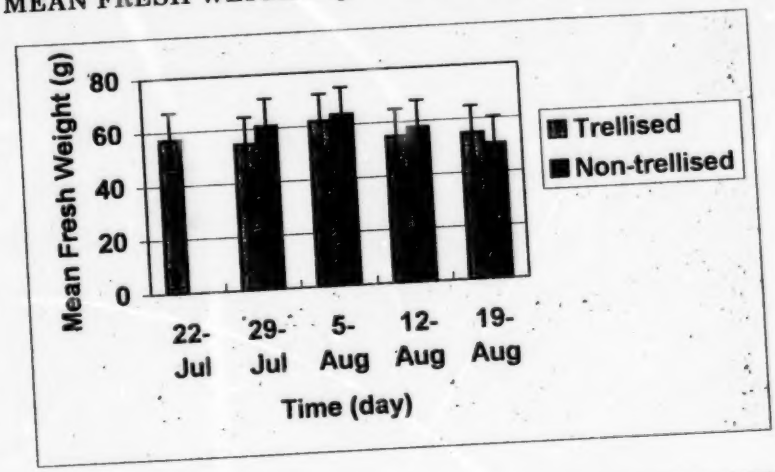


Fig. 1. SX84-34

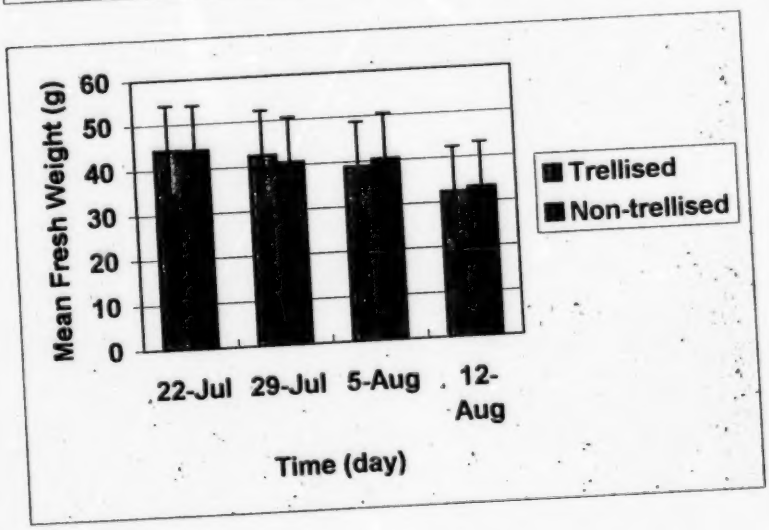


Fig. 2. SX84-35

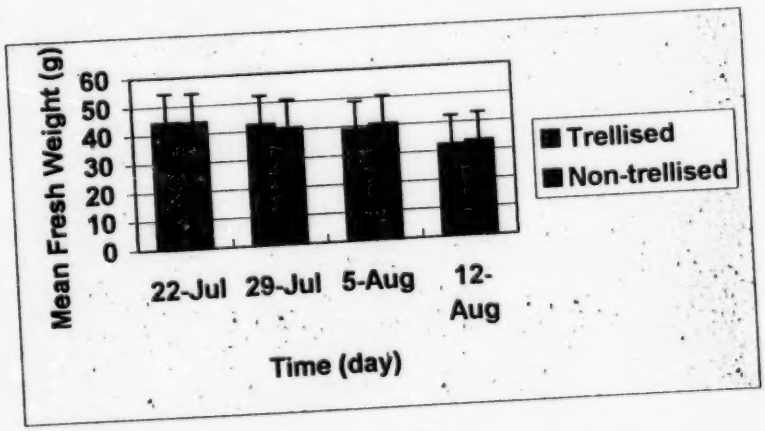


Fig. 3 'Boyne'

MEAN FRESH WEIGHT (g) OF 20 BERRIES、July22-August19、2000

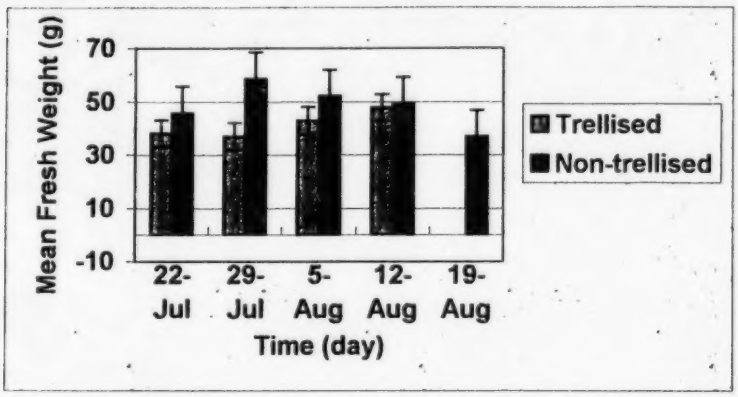


Fig. 4. Min 656

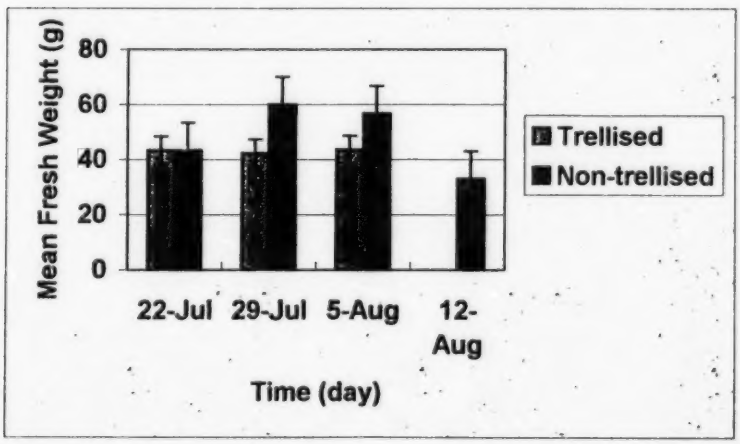


Fig. 5 Min 657

MEAN DRY WEIGHT (g) OF 20 BERRIES, July22-August19, 2000

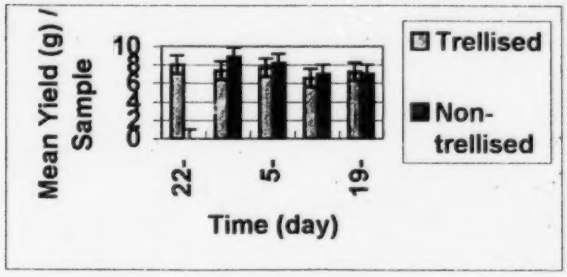


Fig. 6. SX 84-34

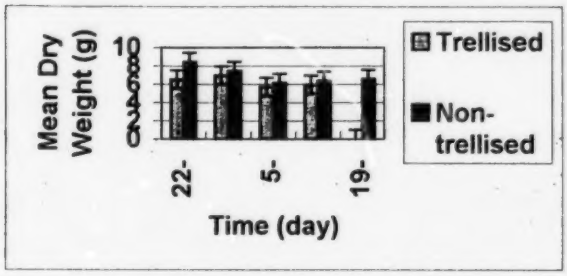


Fig. 7. SX 84-35

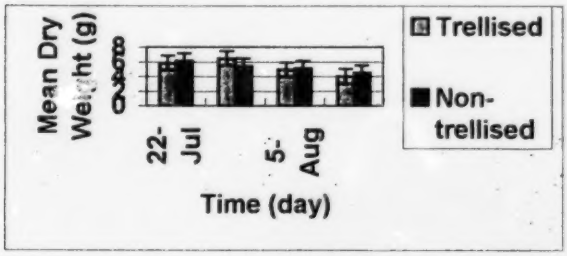


Fig. 8. 'Boyne'

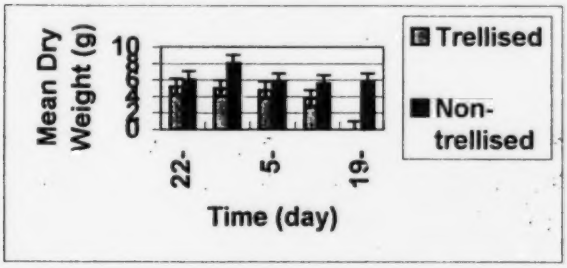


Fig. 9. Min656

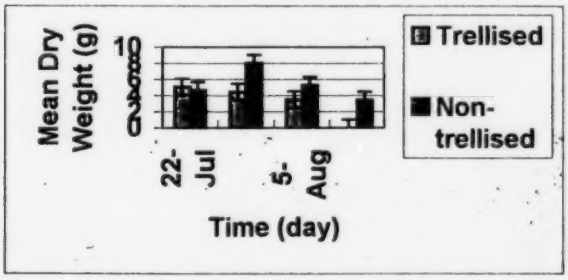
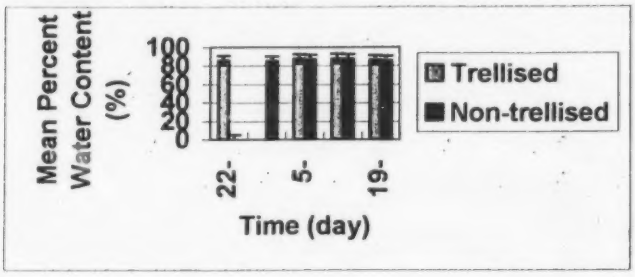


Fig. 10. Min 657

MEAN % WATER CONTENT OF 20 BERRIES, July22-August19, 2000



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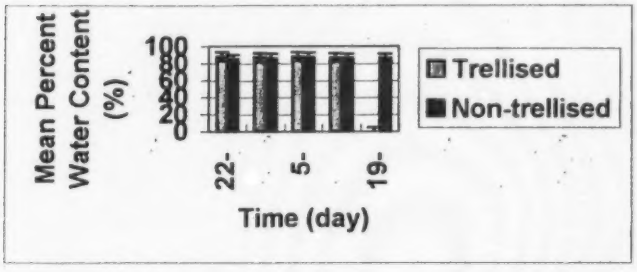


Fig. 12. SX84-35

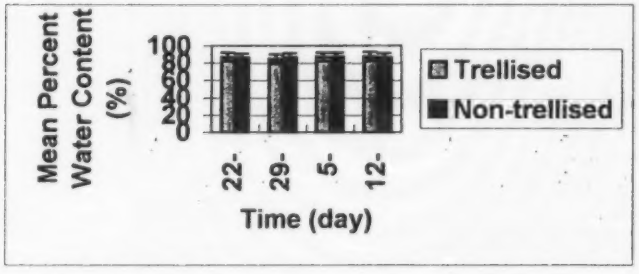


Fig. 13 'Boyne'

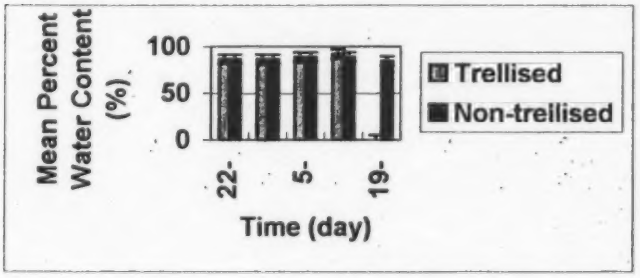


Fig. 14 Min 656

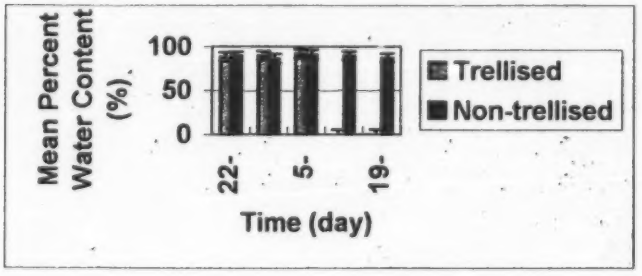


Fig. 15. Min 657

MEAN pH, July 22 – August 19, 2000

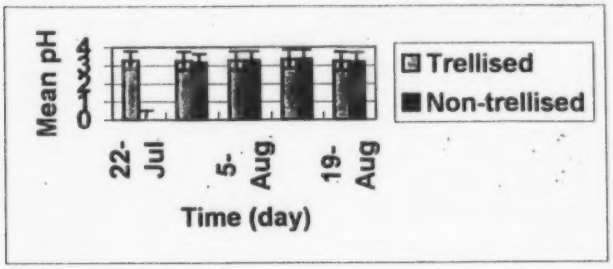


Fig. 16 SX84-34

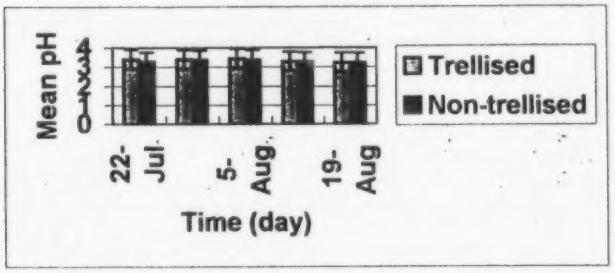


Fig. 17 SX84-35

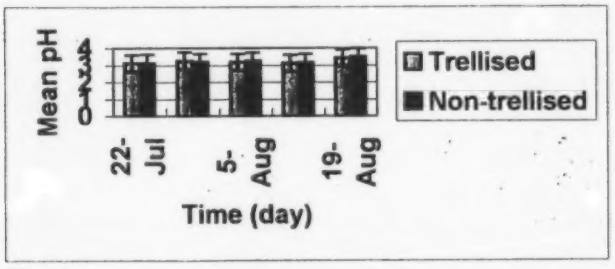


Fig. 18. 'Boyne'

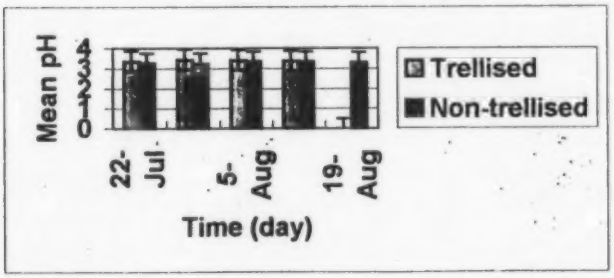


Fig. 19 Min 656

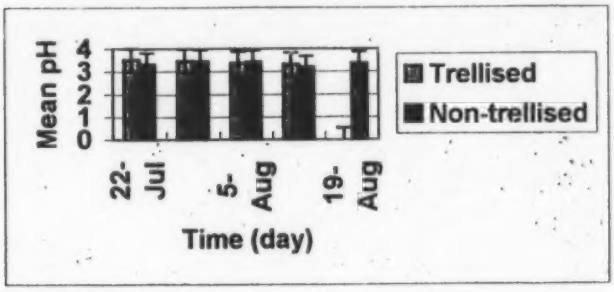


Fig. 20. Min 657

MEAN BRIX, July 22 – August 19, 2000

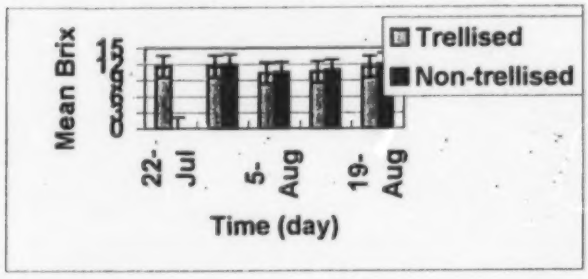


Fig. 21 SX84-34

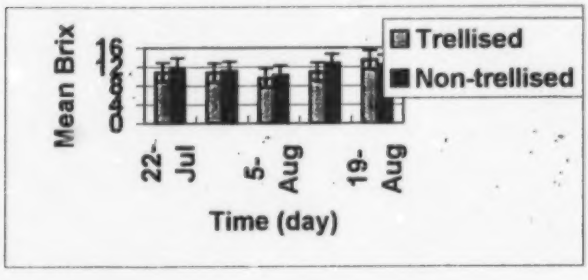


Fig. 22. SX84-35

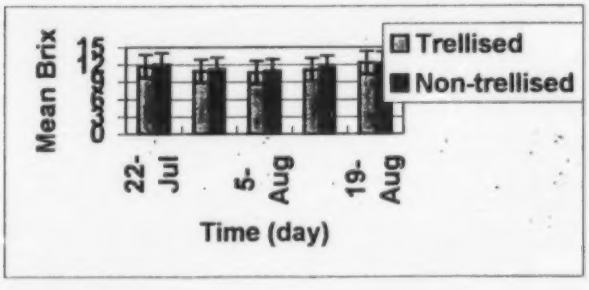


Fig. 23. 'Boyne'

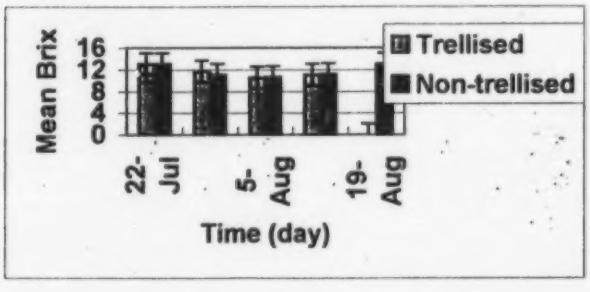


Fig. 24. Min 656

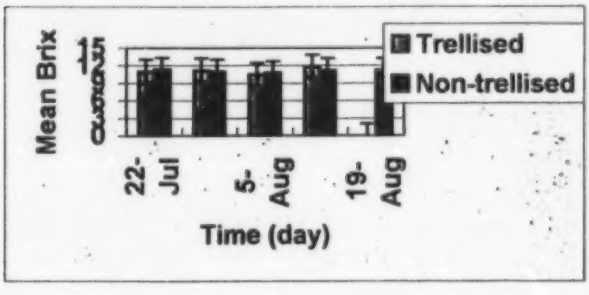


Fig. 25. Min 657

COLOUR – Mean L-value, July 22 – August 19, 2000

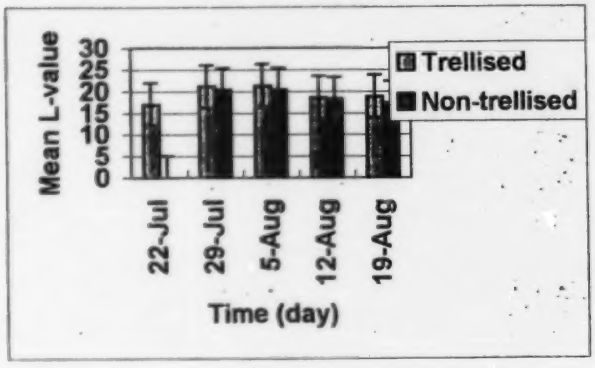
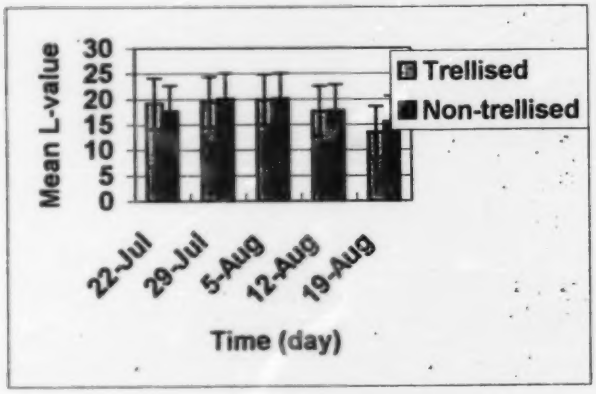


Fig. 26 SX84-34



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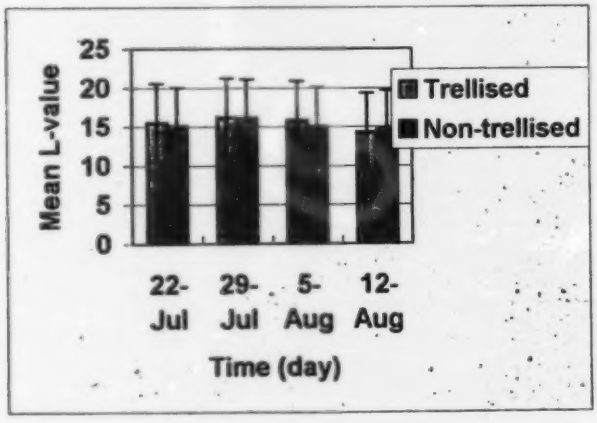


Fig. 28 'Boyne'

COLOUR – Mean L-value, July 22 – August 19, 2000

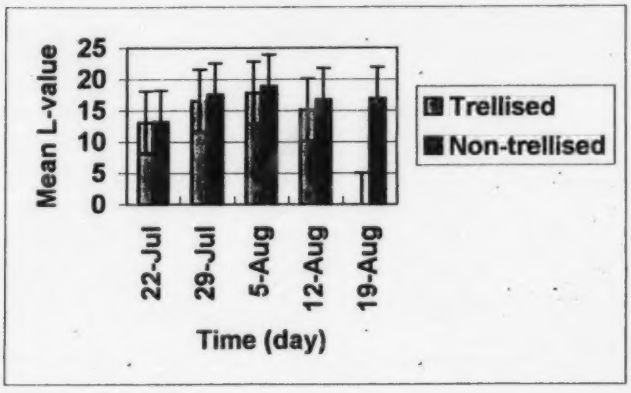


Fig. 29 Min 656

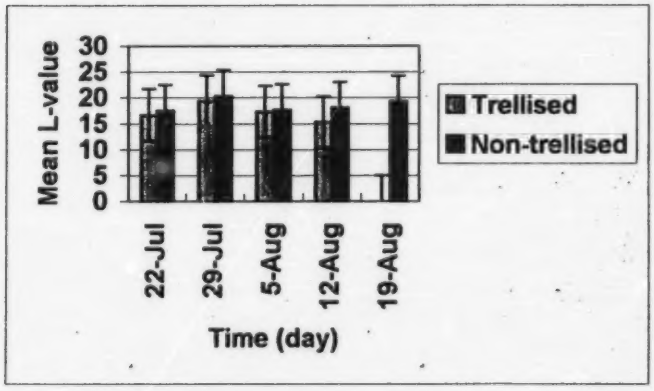


Fig. 30. Min 657

COLOUR – Mean A-value, July 22 – August 19, 2000

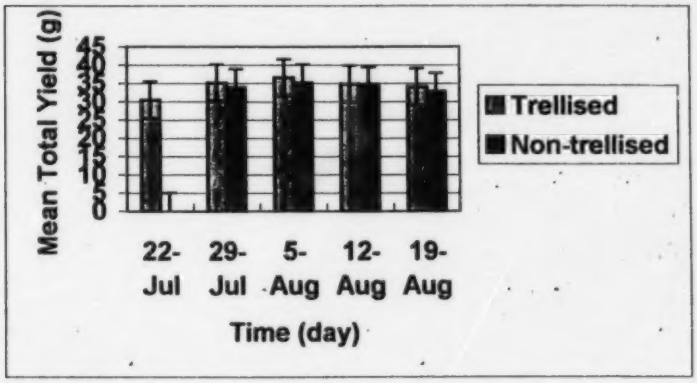


Fig. 31 SX84-34

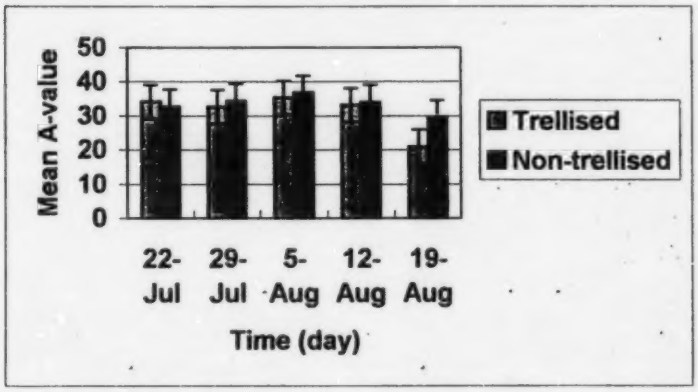


Fig. 32 SX84-35

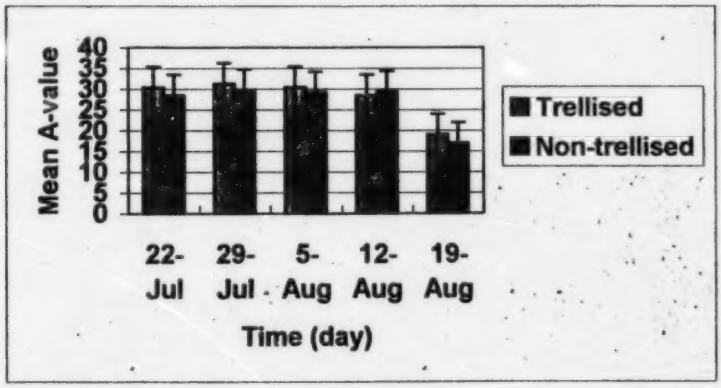


Fig. 33 'Boyne'

COLOUR – Mean A-value, July 22 – August 19, 2000

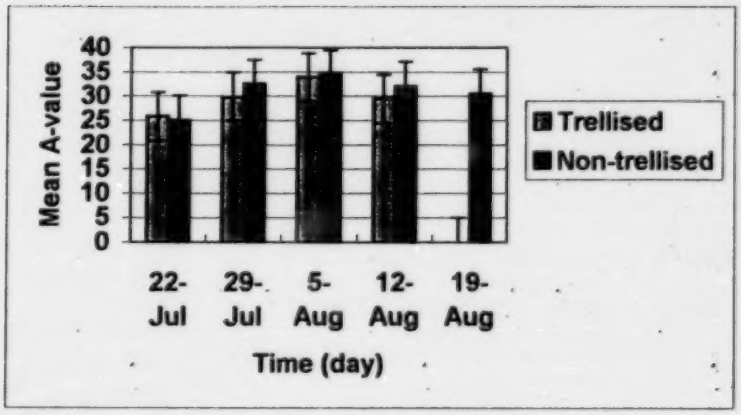


Fig. 34 Min 656

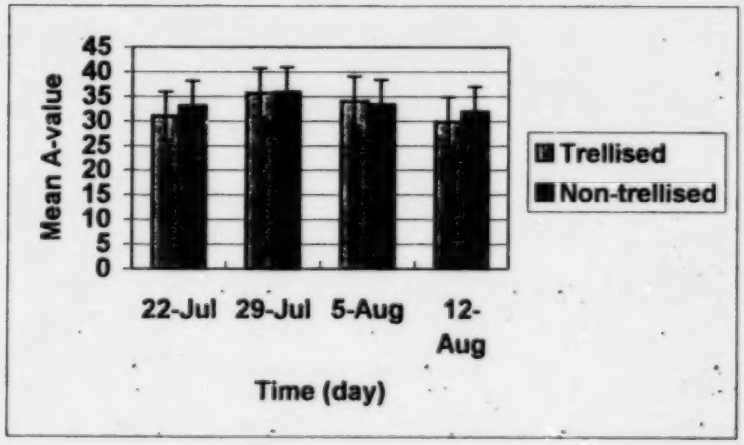


Fig. 35 Min 657

COLOUR – B-Value July 22 – August 19, 2000

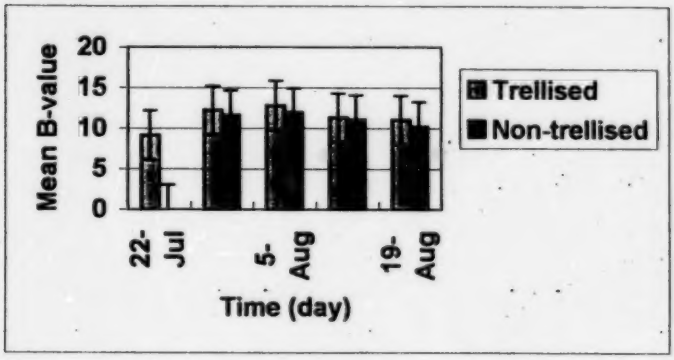


Fig. 36 SX84-34

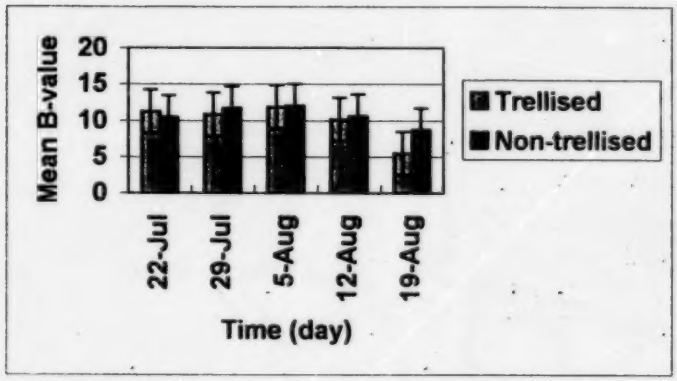


Fig. 37 SX84-35

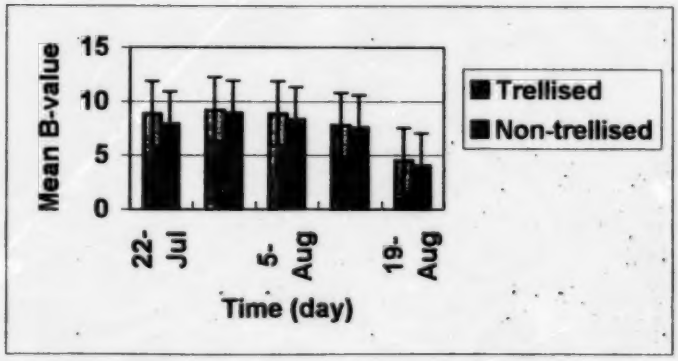


Fig. 38 'Boyne'

COLOUR – B-Value July 22 – August 19, 2000

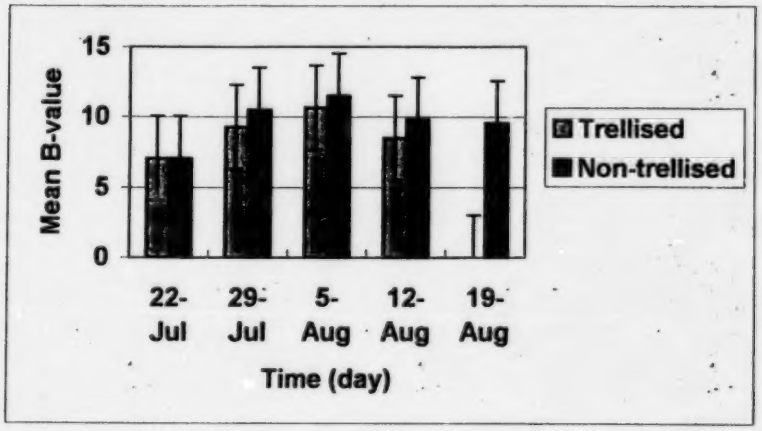


Fig. 39 Min 656

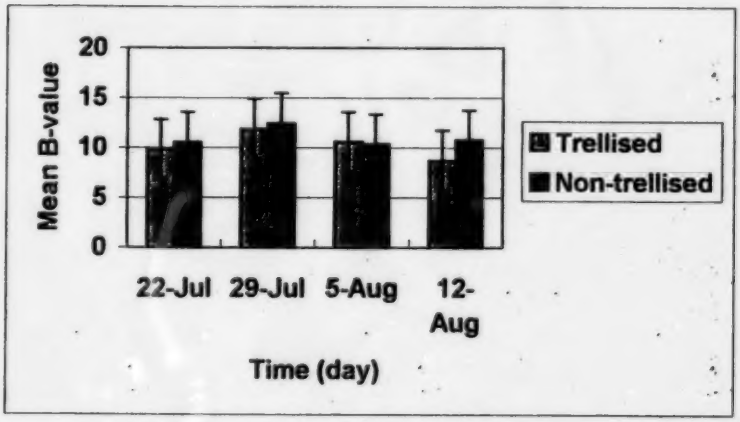


Fig. 40 Min 657

MEAN PICKING TIME/CANE (min.)

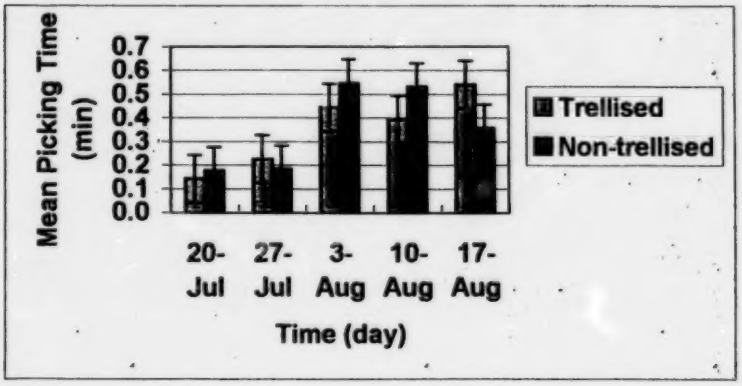


Fig. 41 SX84-34

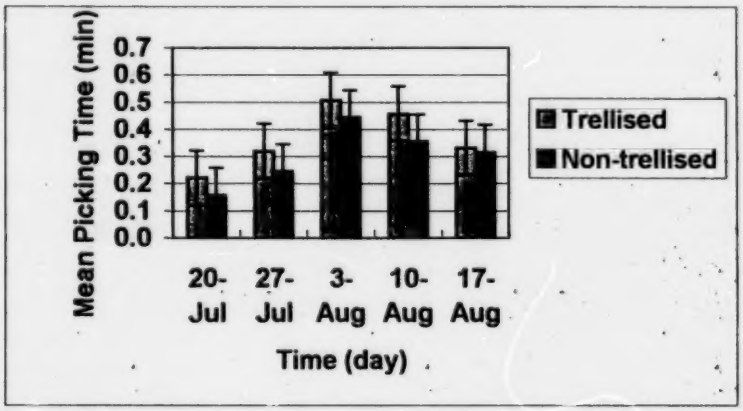


Fig. 42 SX84-35

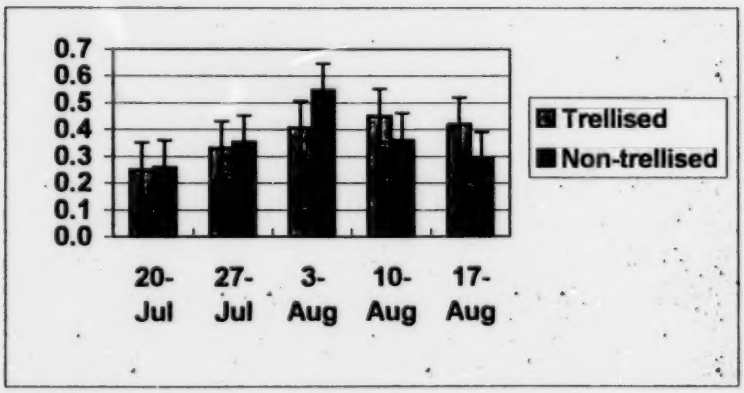


Fig. 43 'Boyne'

MEAN PICKING TIME/CANE (min.)

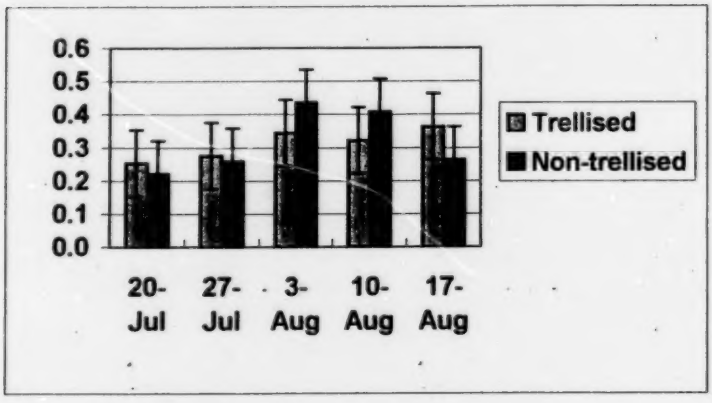


Fig. 44 Min 656

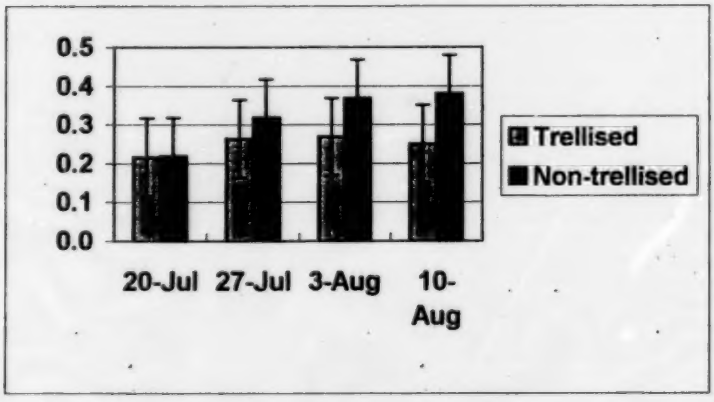


Fig. 45 Min 657

MEAN TOTAL YIELD/CANE (g FW), July 20 – August 17, 2000

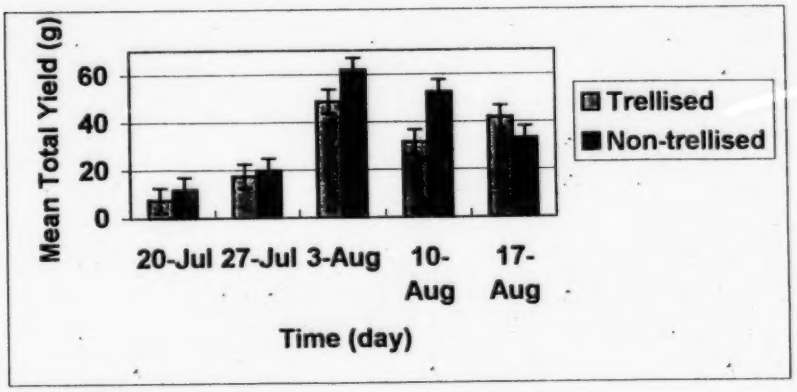


Fig. 46. SX84-34

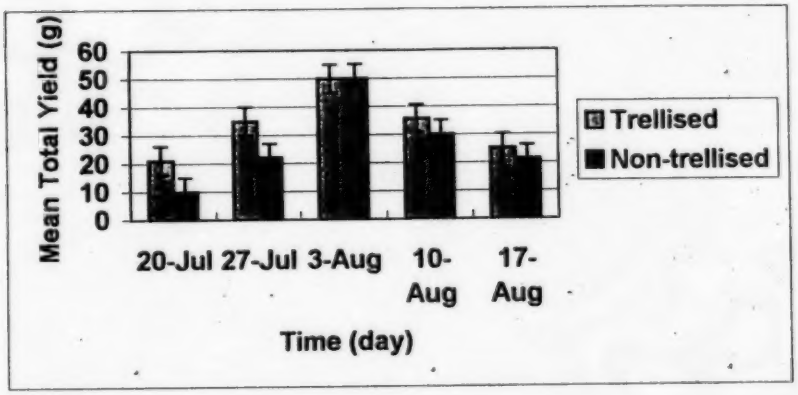


Fig. 47 SX84-35

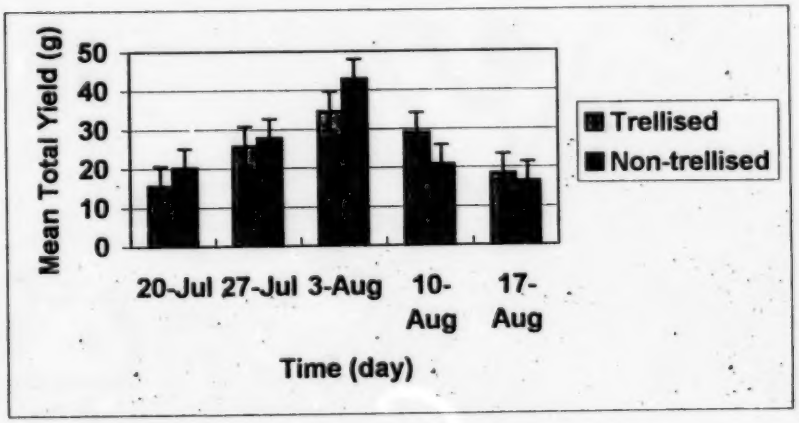


Fig. 48 Boyne

MEAN TOTAL YIELD/CANE (g FW), July 20 – August 17, 2000

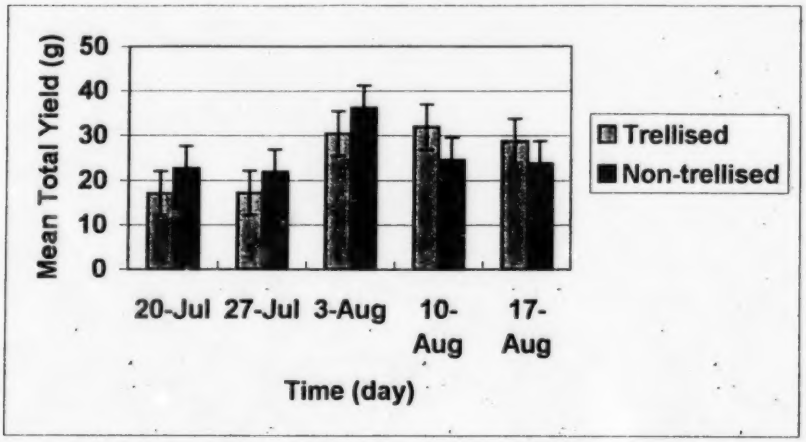


Fig. 49 Min 656

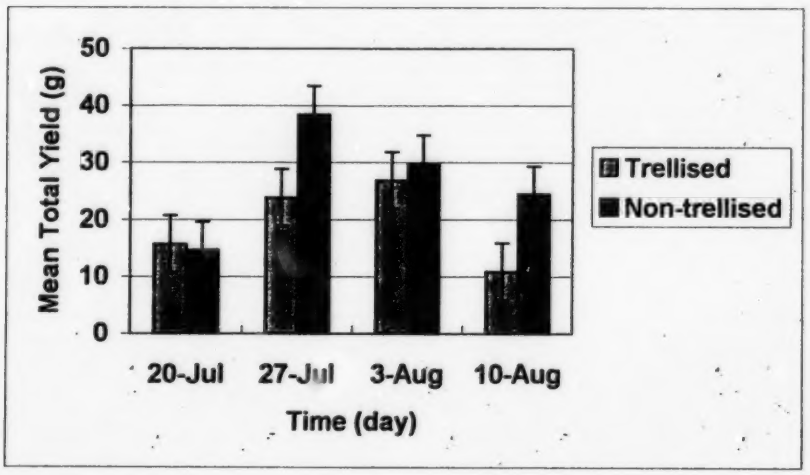


Fig 50 Min 657

Section B: Primocane Selections

Section B: Primocane selections

Two primocane selections show promise for Saskatchewan. They are SX81-205-15 (Fig. A) and SX81-205-9 (Fig. B). These 2 primocane selections are larger in size than the largest floricane release, cultivar SK-Red Mammoth (Fig. C) where a higher number of berries from the floricane cultivar could be placed into the same sized petri dish than the 2 primocane types. Selection SX81-205-15 had a mean diameter of 9.5 mm (Fig. A). Selection SX81-205-9 had a mean diameter of 10.5 mm (Fig. B).

b) Primocane Results and Discussion (Figs. A – C, 1 – 20)

a) Yield
Yield on a total grams per meter over the season from August 7 to September 9 was monitored:

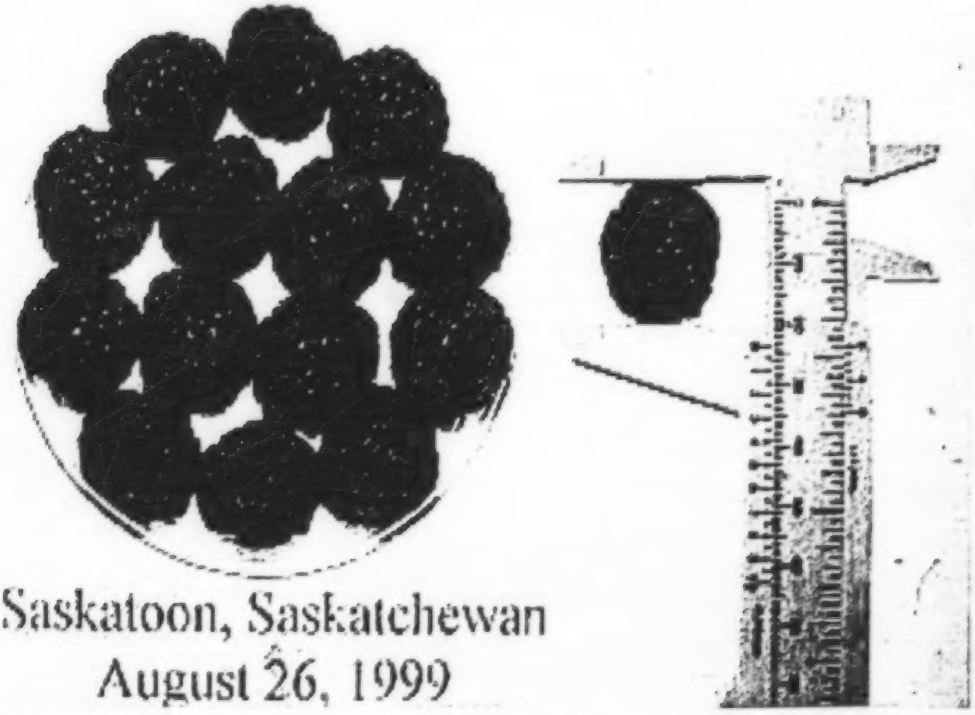
M8006, = 606.3 g
M8112, = 761.7 g
M8114, = 777.7 g
SX81-205-9, = 1955.3 g
SX81-205-15, = 1139.3
Min 659, = 567.4 g
Min 629, = 644.2

Thus, highest yield was recorded on SX81-205-9. This is likely due to its early maturity (Fig. 14). The highest initial yield on August 7 was found on SX81-205-9 (Fig. 14). It also had the largest mean berry size at 2.5 g per berry (Fig. 7). By contrast, the mean fruit weight of primocane cultivar, Heritage, was 1.81 g/berry as averaged over 3 years and 3 different row spacings (Myers, 1993). Thus, our primocane selections have a significantly higher fruit weight. This fruit weight is also comparable with Double Delight which has a mean fruit weight of 2.6 g. (Davidson, 1994a). SX81-205-15 yield increased through the season but did not reach yields of SX81-205-9 (Fig. 13). Mean berry size of SX81-205-15 was comparable to SX81-205-9 (Figs. 6, 7). Smallest berry size was found in M8006 (Fig. 1). Finally, SX81-205-9 has 60% greater yield than Double Delight (1220 g/m^2) on a per metre sq. basis (Davidson, 1994a). Yields should continue to be taken on an annual basis with varying cane densities to determine if these differences are consistent.

- PH (Fig. 15)
  - pH varied between primocane selections from Min 659 (3.07 pH) to M8114 and M8006 (3.27 pH). While this variation was significant, it is not clear if a taste test will show consumer discrimination. Nevertheless, it is higher than the reported pH of 2.92 for Double Delight. Additional tests over years should be performed to determine if this pH level is consistent.
  - PH changed between September 2 and 9th dates..

Fig. A. Primocane raspberry selection SX81-205-15 from the University of Saskatchewan field plots, 1999.

Primocane Raspberries
SX81-205-9



Saskatoon, Saskatchewan
August 26, 1999

Fig. B Primocane raspberry selection SX81-205-9 from the University of Saskatchewan field plots, 1999.

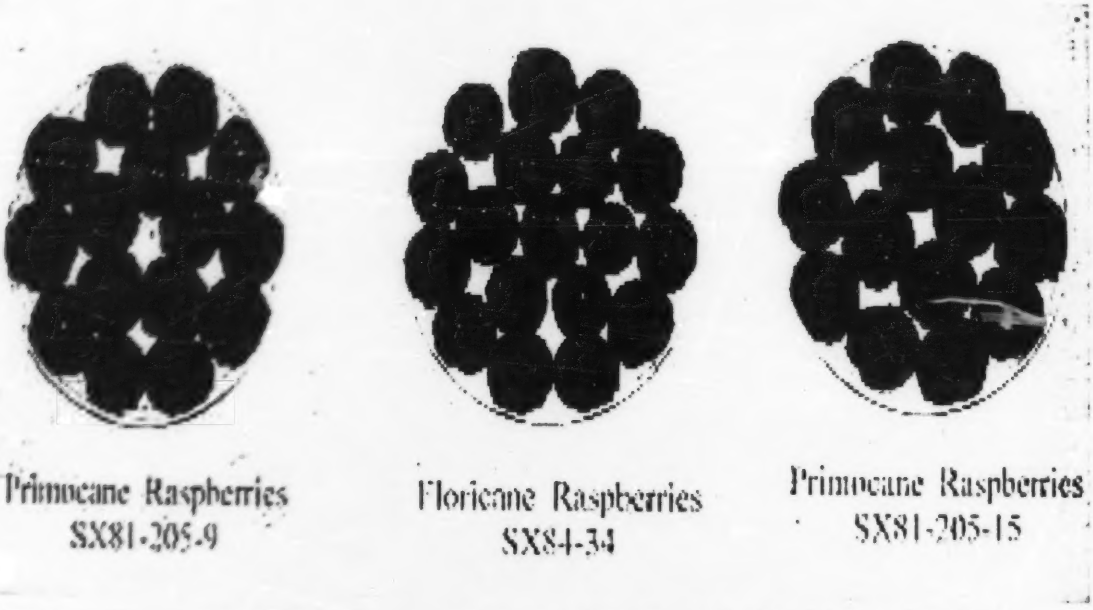


Fig. C Size comparison between primocane selections and the cultivar, SK-Red Mammoth.

- Brix (Fig. 16)
  - No difference in Brix for any of the primocane selections on September 2 or 9, 2000. Brix levels remained at a mean of 12.5 Brix units throughout the season. This is higher than the current prairie standard cultivar, Double Delight which was reported to have a mean Brix level of 11 (Davidson, 1994a).

- Colour

L-Values represent the degree of lightness of colour and the chroma values are a measure of the intensity or brightness of the hue (visible colour) (Perkins-Veazie and Nonnecke, 1992).

No difference in Colour components were detected for any of the primocane selections on September 2 or 9, 2000 except for SX81-205-15 which had a low "A" value and subsequently, a low chroma value (Table 1, Figs. 17-19). This low value may reflect poorer storability since colour was taken off of frozen samples. Berry colour did not darken (L values did not decrease) over the sampling period. However, frozen berries were used which may have normalized the results between selections and sampling dates.

Table 1. 2000 values. Chroma: calculated as the square root of $a^2 + b^2$ (Singha and Townsend, 1989)

	a value		b value		Chroma	
Cultivar	**Sept. 2**	**Sept. 9**	**Sept. 2**	**Sept. 9**	**Sept. 2**	**Sept. 9**
M 8006	32	33	11	12	33.8	35.1
M 8112	30	28	10	7.5	31.6	28.9
M 8114	30	36	10	12.5	31.6	38.1
SX81205-9	35	35	12.5	12.5	37.2	37.2
SX81205-15	12	12	13	13	17.7	17.7
Min 625	35	35	12.5	12.5	37.2	37.2
Min 659	32	32	11	11	33.8	33.8

PRIMOCANE Mean Fresh Weight (g) per berry, Aug. 7 – Sept. 11, 2000

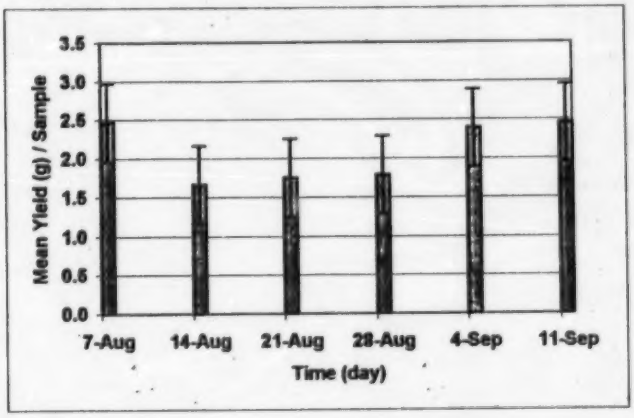


Fig. 1 M8006

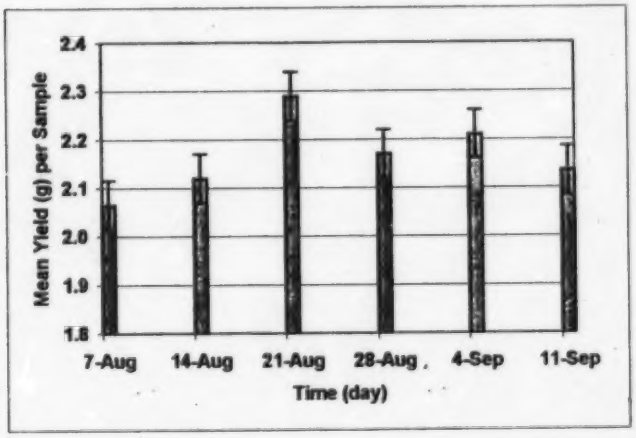


Fig. 2 M8112

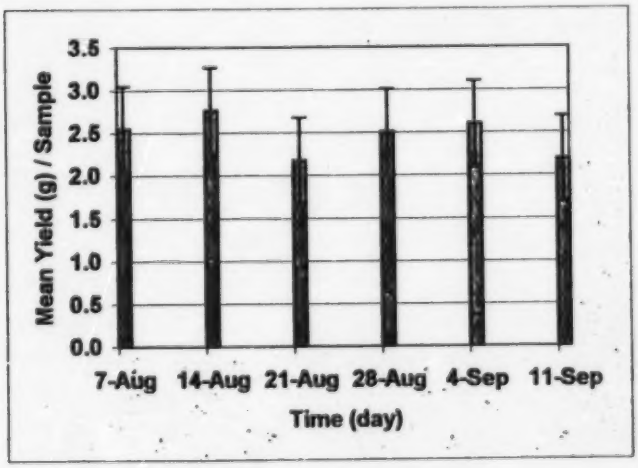


Fig. 3 M8114

PRIMOCANE Mean Fresh Weight (g) per berry, Aug. 7 – Sept. 11, 2000

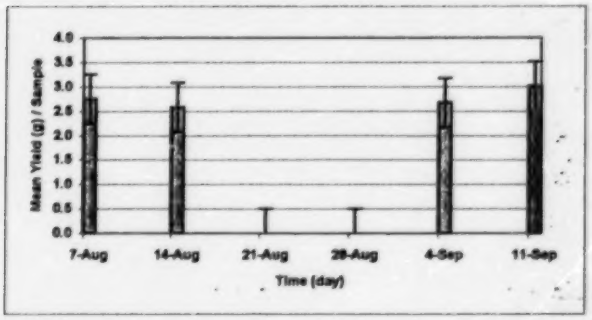


Fig. 4 Min 659

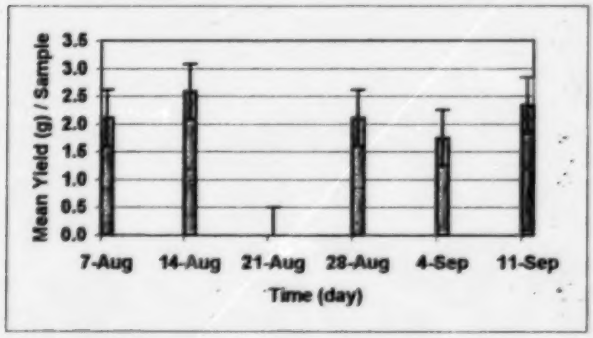


Fig. 5 Min 629

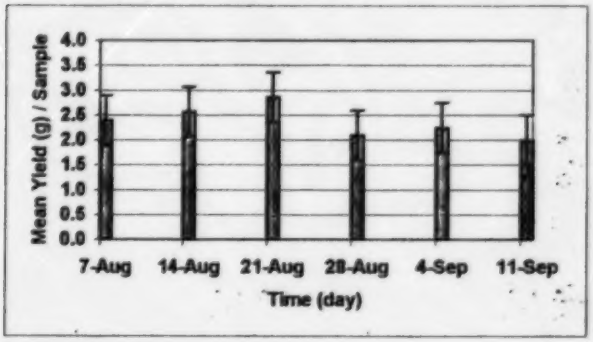


Fig. 6 SX81-205-15

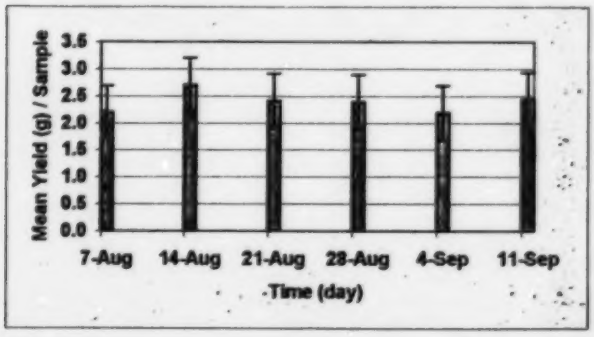


Fig. 7 SX81-205-9

MEAN TOTAL YIELD (g FW), August 7 – Sept. 11, 2000

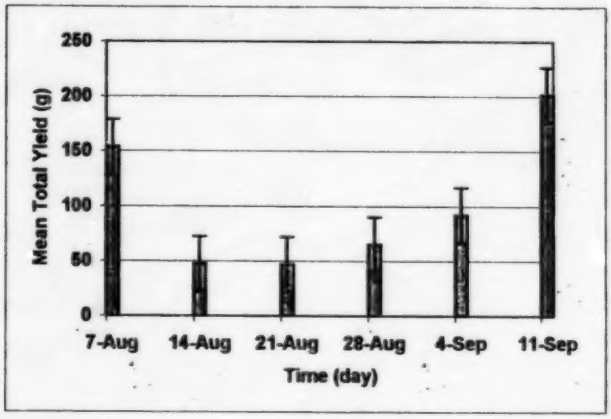


Fig. 8 M8006

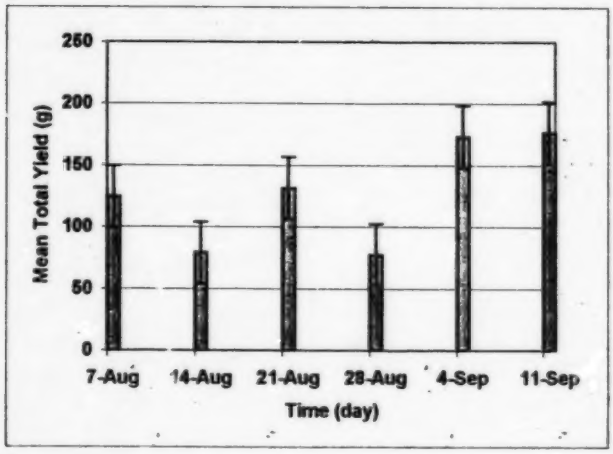


Fig. 9 M8112

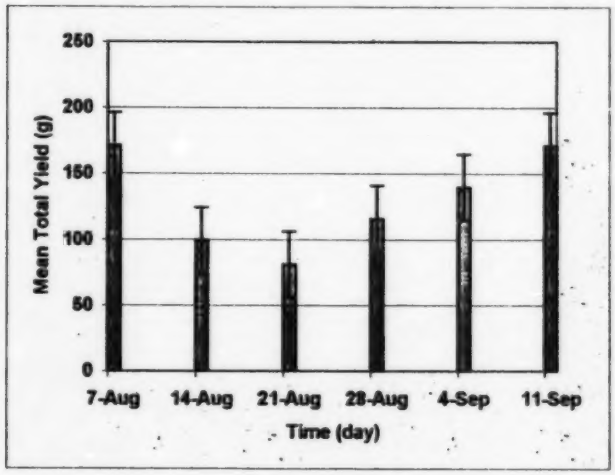


Fig. 10 M8114

MEAN TOTAL YIELD (g FW), August 7 – Sept. 11, 2000

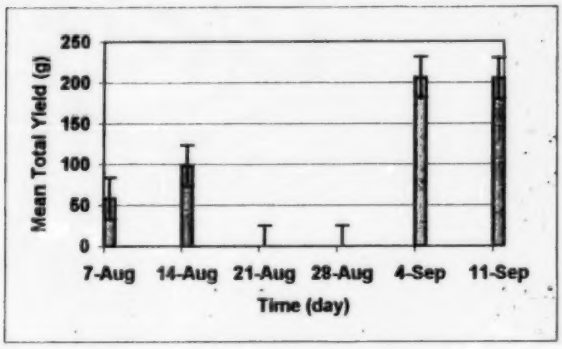


Fig. 11 Min 659

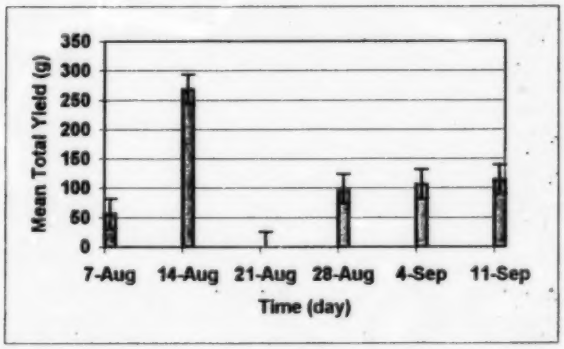


Fig. 12 Min 629

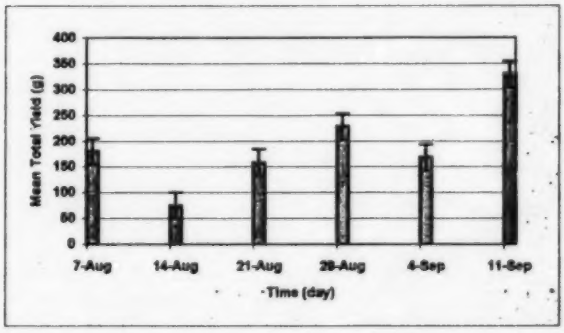


Fig. 13 SX81-205-15

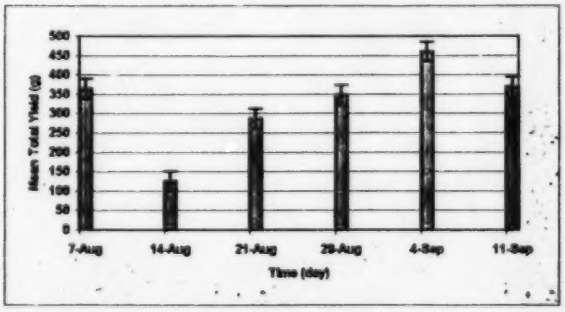


Fig 14 SX81-205-9

Fig. 15. PRIMOCANE Mean pH, Sept. 2, 9, 2000

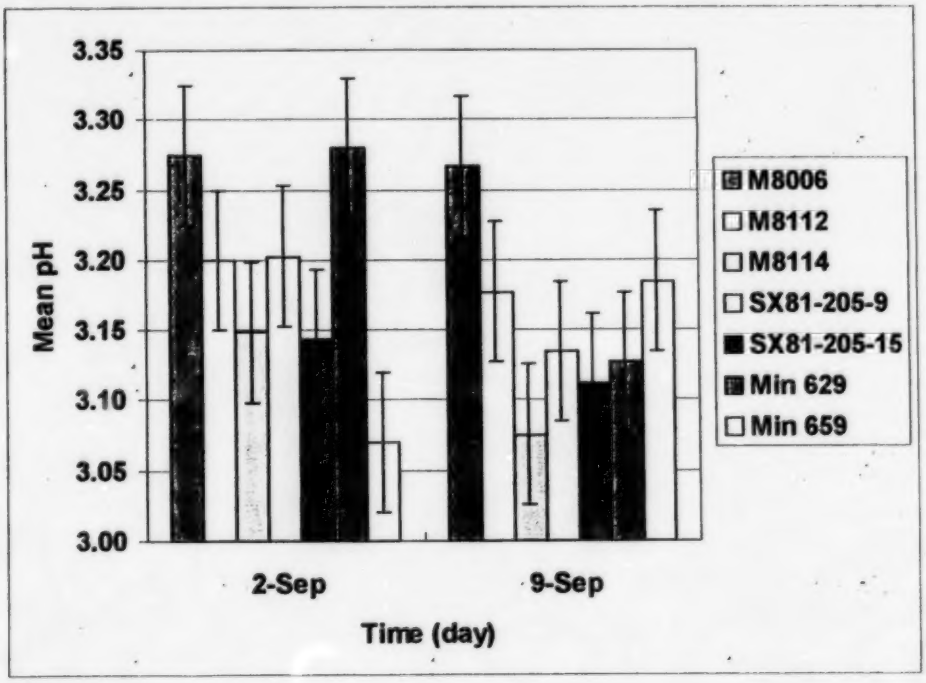


Fig. 16. PRIMOCANE, MEAN BRIX Sept. 2, 9, 2000

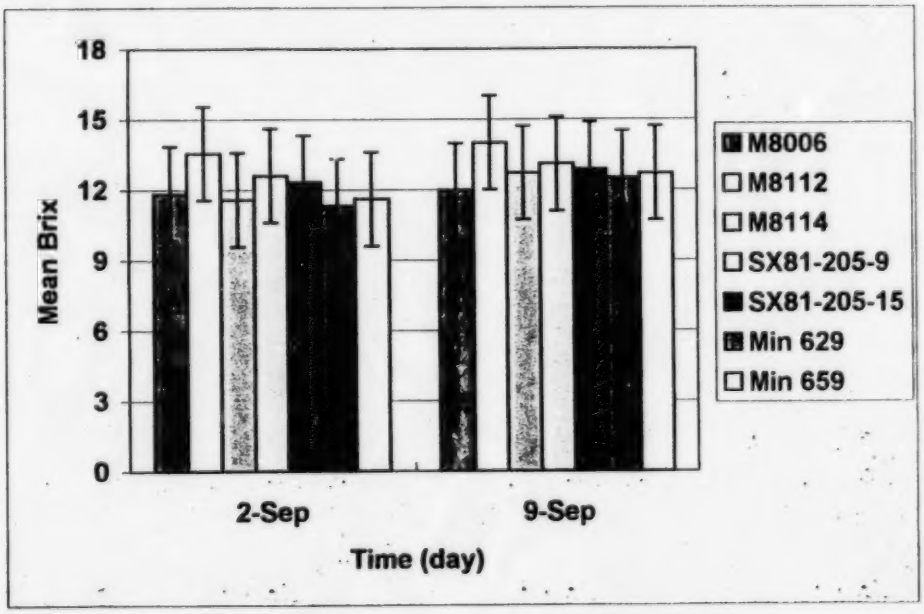


Fig. 17. PRIMOCANE, COLOUR, L-Value, Sept. 2, 9, 2000

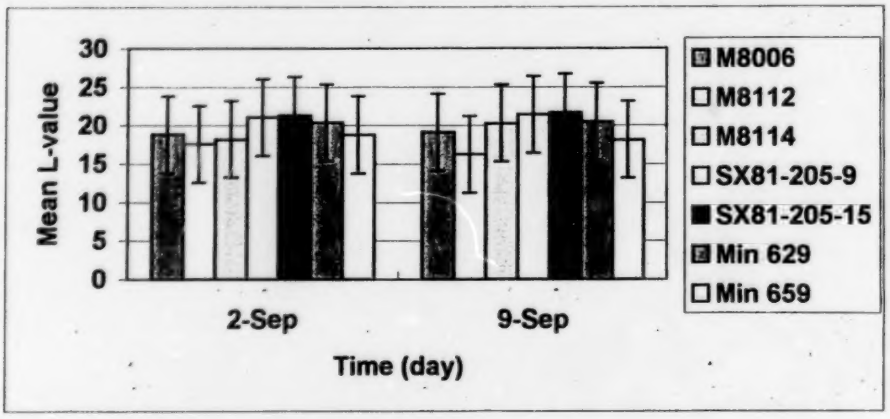


Fig. 18. PRIMOCANE, COLOUR, A-Value, Sept. 2, 9, 2000

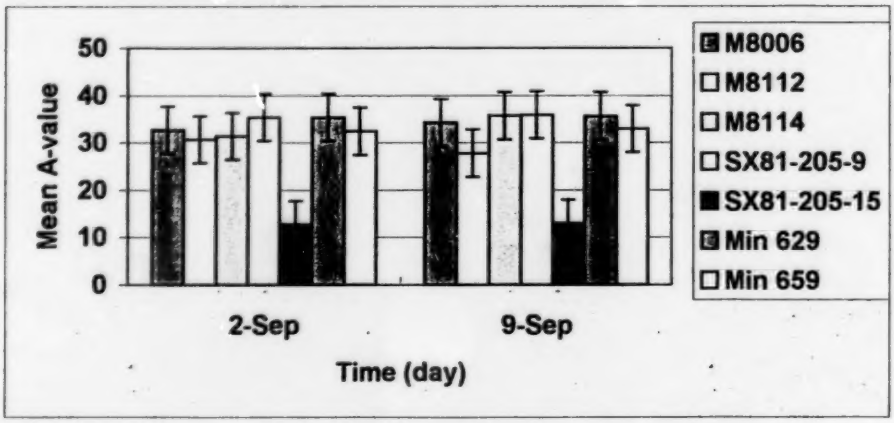


Fig. 19. PRIMOCANE, COLOUR, B-Value, Sept. 2, 9, 2000

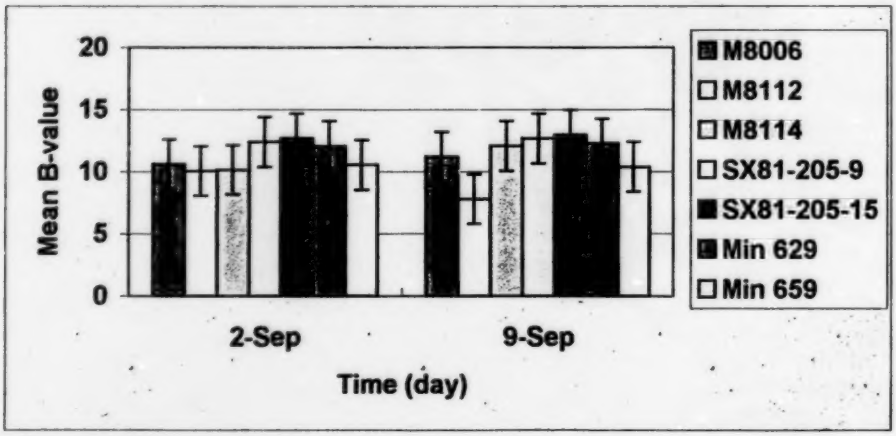


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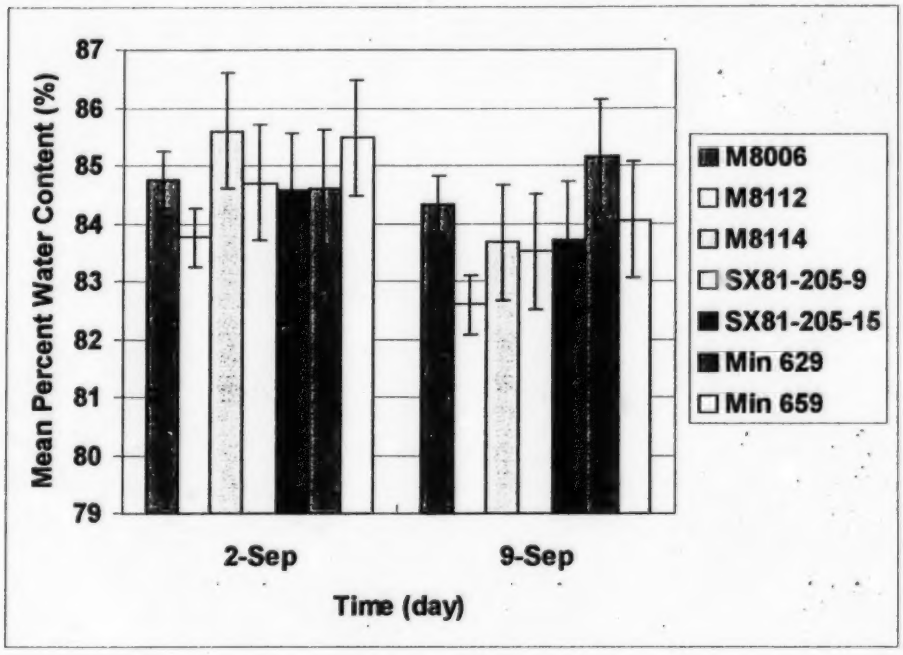
Fig. 20. PRIMOCANE、Mean PercentWater Content, Sept. 2, 9, 2000



Personnel

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- Dr. Karen Tanino (subsequent P.I.)
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- Javad Shaterian (summer assistant)
- Victoria Bishara (summer assistant)
- Corey Walcer (research assistant)
- Moira Green (research assistant)